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Environmental Science and Engineering, Inc.
Gainesville, FL

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QA

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This document provides guidelines to Industrial Environmental Research Laboratory-Cincinnati (IERL-Ci) Project Officers for (1) incorporating quality assurance (QA) criteria in contract procurement and grant awards, (2) monitoring quality assurance of extramural projects, and (3) conducting QA audits for projects involving sampling and analysis activities. The Project Officer's responsibilities are described for the initiation, monitoring, and satisfactory conclusion of contracts, research and demonstration grants, and cooperative agreements of the type normally funded by IERL-Ci. Guidance is provided to assure QA is adequately addressed during project conception and solicitation and that prospective grantees are informed of QA requirements. A technical evaluation system is presented for the evaluation of the QA aspects of proposals and grant applications. The basic elements of an acceptable QA program and of a project QA plan are described, and the Project Officer's role in QA monitoring is discussed. A procedure is described for conducting QA audits of active projects. Checklists are included to assist the Project Officer.

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QUALITY ASSURANCE GUIDELINES FOR IERL-CI PROJECT OFFICERS

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FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory-Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

These quality assurance guidelines consist of three sections:

(1) Quality assurance guidelines for procurement of projects requiring sampling and analysis
(2) Quality assurance guidelines for monitoring of projects requiring sampling and analysis
(3) Quality assurance guidelines for auditing of projects requiring sampling and analysis

The first section provides guidelines and checklists to assist the Project Officer in project conception, preparation of procurement requests, evaluation of proposals, and recommendations for selection to the Contracting Officer. The second section presents quality assurance aspects and checklists to assist in monitoring projects from project initiation through the final report; and the third section presents information in relation to planning and conducting project audits.

Further information may be obtained through the Industrial Environmental Research Laboratory's Quality Assurance Officer, Cincinnati, Ohio.

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ABSTRACT

This report presents quality assurance guidelines to assist Project Officers in the procurement, monitoring, and auditing phases of extramural projects requiring sampling and analysis.

The first section presents guidelines to insure that quality assurance (QA) is adequately addressed during project conception and solicitation and that prospective grantees are informed of QA requirements. A technical evaluation system is presented that should disqualify those offerors who do not provide adequate sampling and analysis QA for the purposes of the program. A checklist is provided for the evaluation of the quality assurance aspects of proposals and grant applications.

In the second section, the Project Officer's responsibilities are described for the initiation, monitoring, and satisfactory conclusion of contracts, research and demonstration grants, and cooperative agreements of the type normally funded by IERL-Ci. The three basic foundations of project quality assurance are described: (1) the contractor's/grantee's quality assurance program, (2) the Project Work Plan, and (3) quality assurance monitoring of the performance of the contractor/grantee. Checklists are included to assist the Project Officer in assessing the completeness of a contractor's or grantee's overall QA program and his Project Work Plan.

The third section provides information concerning the scheduling and performance of laboratory audits. Checklists are provided to assist in performing the audit.

These quality assurance guidelines were submitted in fulfillment of Contract No. 68-03-2656 by Environmental Science and Engineering, Inc. under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period August 1978 to December 1979, and work was completed as of December 1979.

CONTENTS

Disclaimer ii
Foreword iii
Abstract iv
Figures. vii
Tables viii

1. QUALITY ASSURANCE GUIDELINES FOR PROCUREMENT OF PROJECTS REQUIRING SAMPLING AND ANALYSIS

- Introduction. 1
  - Importance of Quality Assurance 1
  - Purpose of These Guidelines 2
  - Definitions of Quality Assurance and Quality Control 3
  - QA in the Procurement Process 5
- QA Criteria in Project Conception and Solicitation. 8
  - Project Conception (Contracts). 8
  - Contract Solicitation 12
  - Project Conception and Application for Research and Demonstration Grants 19
  - Use of Performance Test Samples in Contractor/Grantee Selection. 20
  - Cost Considerations 21
  - Preproposal Conference. 23
- QA Criteria in Technical Evaluation of Proposals and Grant Applications. 23
  - Technical Evaluation of Contract Proposals. 23
  - QA Evaluation Criteria and Scoring Procedures for Contracts 24
  - Written/Oral Discussions with Offerors. 25
  - QA Evaluation of Grant Applications 28
  - Evaluation of Performance Test Samples. 29
- Evaluation of Previous Performance History. 29
- Cost Evaluation 30
- Best and Final Offer Evaluation 31
- Pre-Award Surveys 31

CONTENTS (Continued)

2. QUALITY ASSURANCE GUIDELINES FOR MONITORING OF PROJECTS REQUIRING SAMPLING AND ANALYSIS

Introduction 35
Project Officer's QA Responsibilities 37
    Contracts 37
    Grants and Cooperative Agreements 40
    Summary of the Project Officer's Role in Achieving QA 42
The Contractor's/Grantee's QA Program 43
    Elements of a QA Program 43
    QA Program Checklist 47
The Project Work Plan 48
    Elements of a Project QA Plan 48
    Project Work Plan Checklist 50
Project QA Monitoring 50
    Methods of Monitoring Contractor/Grantee QA 50

3. QUALITY ASSURANCE GUIDELINES FOR AUDITING OF PROJECTS REQUIRING SAMPLING AND ANALYSIS

Introduction 53
    Quality Assurance Audits 53
    Quality Assurance in Audits 53
Quality Assurance Audit Guidelines 54
    When to Conduct a Quality Assurance Audit 54
    Audit Worksheet and Checklist 54
    Use of Performance Test Samples 58
Conducting the Quality Assurance Audit 58
    Review of Worksheet 58
    Site Visit 60
    Quality Assurance Audit Report 62

4. CONCLUSIONS

Procurement 67
Monitoring 67
Auditing 67

BIBLIOGRAPHY 68

APPENDICES

A. Quality Assurance Evaluation Criteria Checklist for Proposals and Grant Applications Offering Sampling and Analysis Services 71
B. Quality Control Performance/Reference Test Samples. 75
C. EPA-Accepted Analytical Methods 79
D. Quality Assurance Program Checklist 93
E. Project Quality Assurance Plan Checklist. 105
F. Quality Assurance Pre-Audit Worksheet 113
G. Instrumentation, Equipment, and Personnel Skill Rating for Specific Methods 126
H. Sample Preservation Methods and Recommneded Holding Times 146
I. Quality Assurance Audit Checklist 150

GLOSSARY 179

FIGURES

Number		Page
1	Quality assurance (QA) and quality control (QC) at IERL-Ci	4
2	Processing sequence for contract source evaluation and selection	6
3	Processing sequence for research and demonstration grants and cooperative agreements	9
4	Example of use of QA evaluation criteria checklist for scoring proposals	26
5	Example of technical evaluation scoring system	27
6	Foundations of project quality assurance	36
7	Contracts administration	38
8	Grants and cooperative agreements administration	41
9	Quality assurance audit report	63

TABLES

Number Page

1 Assignment of Evaluation Points for QA 11

2 Evaluation of the Importance of Sampling and Analysis QA . . . 13

3 Example of the Assessment of the Importance of Sampling and Analysis QA 15

4 Example Technical Evaluation Criteria Incorporating Quality Assurance Requirements 17

5 Suggested Criteria for Using Performance Test Samples for Offeror Evaluation 22

6 Criteria for Conducting a Pre-Award Survey 32

7 Suggested Pre-Award Survey Agenda 34

8 Available Quality Assurance Audit Procedures 56

9 Recommended Agenda for QA Audit Site Visit 61

SECTION 1

QUALITY ASSURANCE GUIDELINES FOR PROCUREMENT OF PROJECTS REQUIRING SAMPLING AND ANALYSIS

INTRODUCTION

Importance of Quality Assurance

Quality assurance (QA) encompasses all actions taken by an organization to achieve accurate and reliable results for programs undertaken. An established QA program is essential for any organization to produce valid sampling and analytical data to support research, demonstration, and monitoring efforts. QA requirements are becoming increasingly more important to the Environmental Protection Agency (EPA) since:

1. The number of commercial laboratories and research institutions participating in sampling and analysis programs is increasing,
2. The sampling and analytical equipment and procedures used are becoming more varied and complex,
3. There is an increasing movement toward consolidated data bases,
4. More and more data must withstand legal scrutiny, and
5. Policy decisions of national economic importance must be made on the basis of reliable data.

It is the responsibility of IERL-Ci to assist in developing and demonstrating new and improved pollution control technology that will meet our nation's needs both efficiently and economically. To accomplish this, our research must conform to the highest practicable quality assurance standards. Sampling and analytical programs are an important aspect of most research and demonstration projects conducted by IERL-Ci. Decisions of substantial technical and economic importance are often based on the data generated by IERL-Ci internal sampling and analytical programs, by programs conducted by contractors, and by grantees.*

The Contracting Officer and the Project Officer bear the responsibility of procuring and directing sampling and analysis services for IERL-Ci research and demonstration projects. To fulfill this responsibility, they must be knowledgeable about the basic principles underlying currently acceptable QA practices. These guidelines have been prepared to assist the Project Officer and the Contracting Officer in procuring high quality sampling and analytical services. They establish standards for acceptable QA practices on IERL-Ci research and demonstration projects. Project Officers and Contracting Officers should use these guidelines during preparation of procurement requests and in the technical evaluation of offers and grant applications.

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* Throughout this document, the definition of the word "grant" includes cooperative agreements.

This is the first in a series of three sections describing:

1. Quality assurance guidelines for procurement of projects requiring sampling and analysis,
2. Quality assurance guidelines for monitoring projects requiring sampling and analysis, and
3. Quality assurance guidelines for auditing projects requiring sampling and analysis.

Together, these three sections should assist IERL-Ci Project Officers in applying stringent, but equitable, quality assurance requirements throughout the life of all research and demonstration projects that require sampling and analysis. The requirements should apply to contractor, grantee, and in-house programs equally.

This report is intended as a working document and will be revised as necessary to more accurately describe processes, legal obligations, and current policy.

The Director has assigned to the IERL-Ci Quality Assurance Officer the responsibility of overseeing the quality assurance aspects of all IERL-Ci contracts, research and demonstration grants, and in-house research and demonstration projects. The Quality Assurance Officer has developed the guideline document to assist in fulfilling that responsibility. He is available to work with Project Officers, Contracting Officers, and in-house program managers in any way possible to assure the quality of IERL-Ci projects.

Purpose of These Guidelines

This section has been prepared to insure adequate consideration of QA requirements in the procurement stage of IERL-Ci research and demonstration projects. It provides specific guidelines to: (1) accurately reflect QA requirements in the proposal solicitation stages of procurement; (2) solicit the necessary QA information from prospective contractors, grantees, and bidders to allow accurate evaluation of capabilities; (3) evaluate proposals received with respect to QA; (4) evaluate past performance history of the prospective contractor or grantee, if available; and (5) determine the overall acceptability of an offeror's QA program with respect to the research or demonstration project under consideration.

These guidelines are intended to be used by IERL-Ci Project Officers responsible for procuring sampling and analysis services in support of IERL-Ci research and demonstration projects. They should also be used in the evaluation of research and demonstration grant applications when sampling and analysis aspects are involved. Contracting Officers will find these guidelines of value in preparing Request for Proposal (RFP) packages when soliciting service contracts that include sampling and analysis.

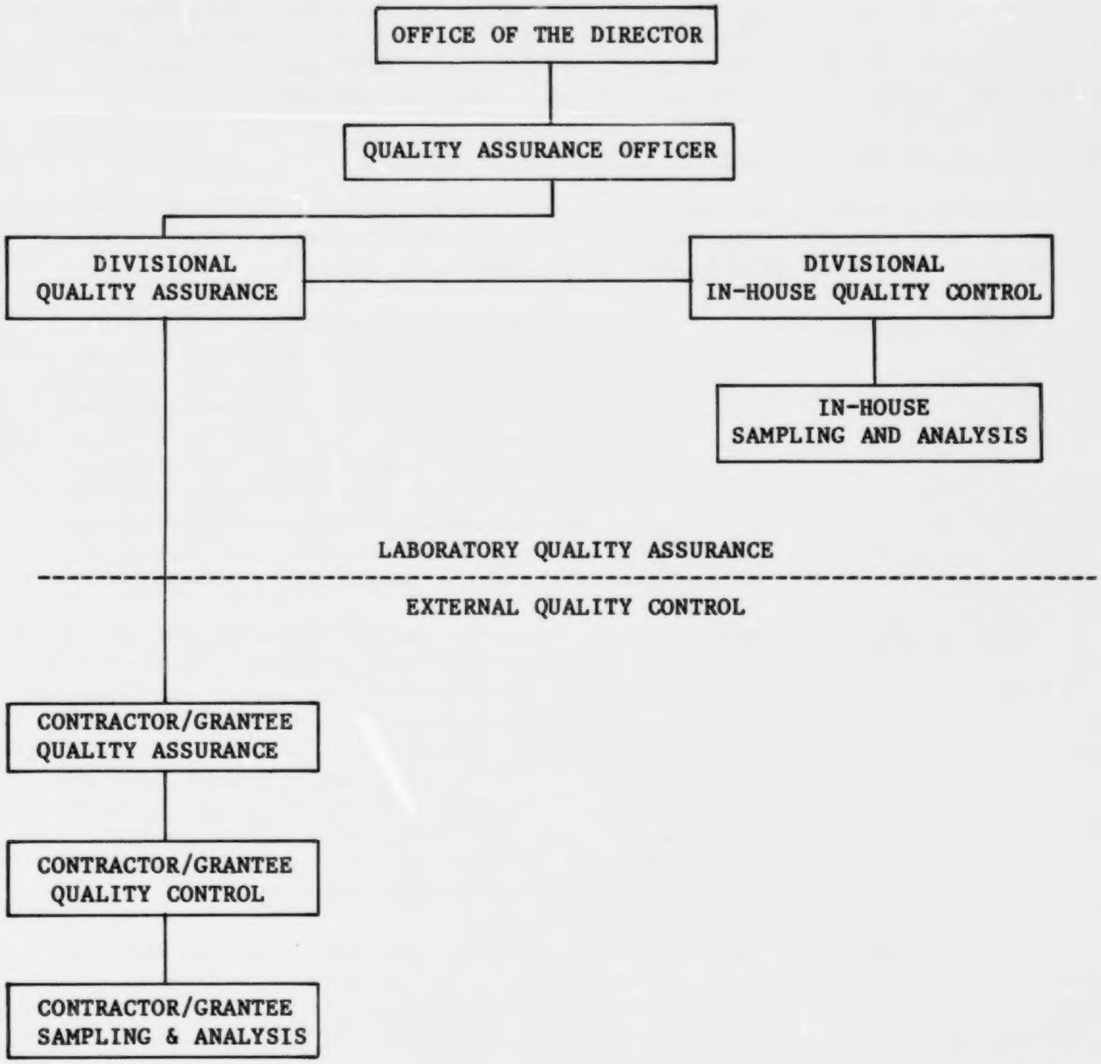
Definitions of Quality Assurance and Quality Control

The terms quality assurance (QA) and quality control (QC) are often used synonymously, although they represent two distinct concepts. The following definitions have been established by the Director, IERL-Ci.

Quality Control (QC):	Actions taken by the Laboratory (IERL-Ci) organization (on in-house projects) and by contractors/grantees (on extramural projects) in day-to-day activities to achieve desired accuracy, reliability, and comparability in the results obtained from sampling and analysis activities. Review by contractors/grantees of their overall quality control activities is "quality assurance" to them, but "quality control" from the Laboratory's viewpoint.
Quality Assurance (QA):	Actions taken by the Laboratory (IERL-Ci) line organization under the specific auspices of the Office of the Director, to assure that quality control policies and procedures are being properly implemented and appropriate levels of accuracy, reliability, and comparability are being achieved in the sampling and analysis activities (including data reduction and handling) of the Laboratory to fulfill the Laboratory's assigned mission.

In broad terms, QA is the overall program that specifies the quality control practices applied to the many individual aspects of a program. Figure 1 graphically presents QA and QC responsibilities at IERL-Ci for both in-house and contractor/grantee sampling and analytical programs.

Simplified definitions of quality assurance and quality control have been adopted by the Office of Monitoring and Technical Support, Office of Research and Development to aid in eliminating confusion. "Quality assurance is the total program for assuring the reliability of monitoring data. Quality control is the routine application of procedures for controlling the measurement process."


OFFICE OF THE DIRECTOR
QUALITY ASSURANCE OFFICER
DIVISIONAL QUALITY ASSURANCE
DIVISIONAL IN-HOUSE QUALITY CONTROL
IN-HOUSE SAMPLING AND ANALYSIS
LABORATORY QUALITY ASSURANCE
EXTERNAL QUALITY CONTROL
CONTRACTOR/GRANTEE QUALITY ASSURANCE
CONTRACTOR/GRANTEE QUALITY CONTROL
CONTRACTOR/GRANTEE SAMPLING & ANALYSIS

SOURCE: In-house memorandum from IERL-Ci Director, March 1978.

Figure 1. Quality assurance (QA) and quality control (QC) at IERL-Ci.

QA in the Procurement Process

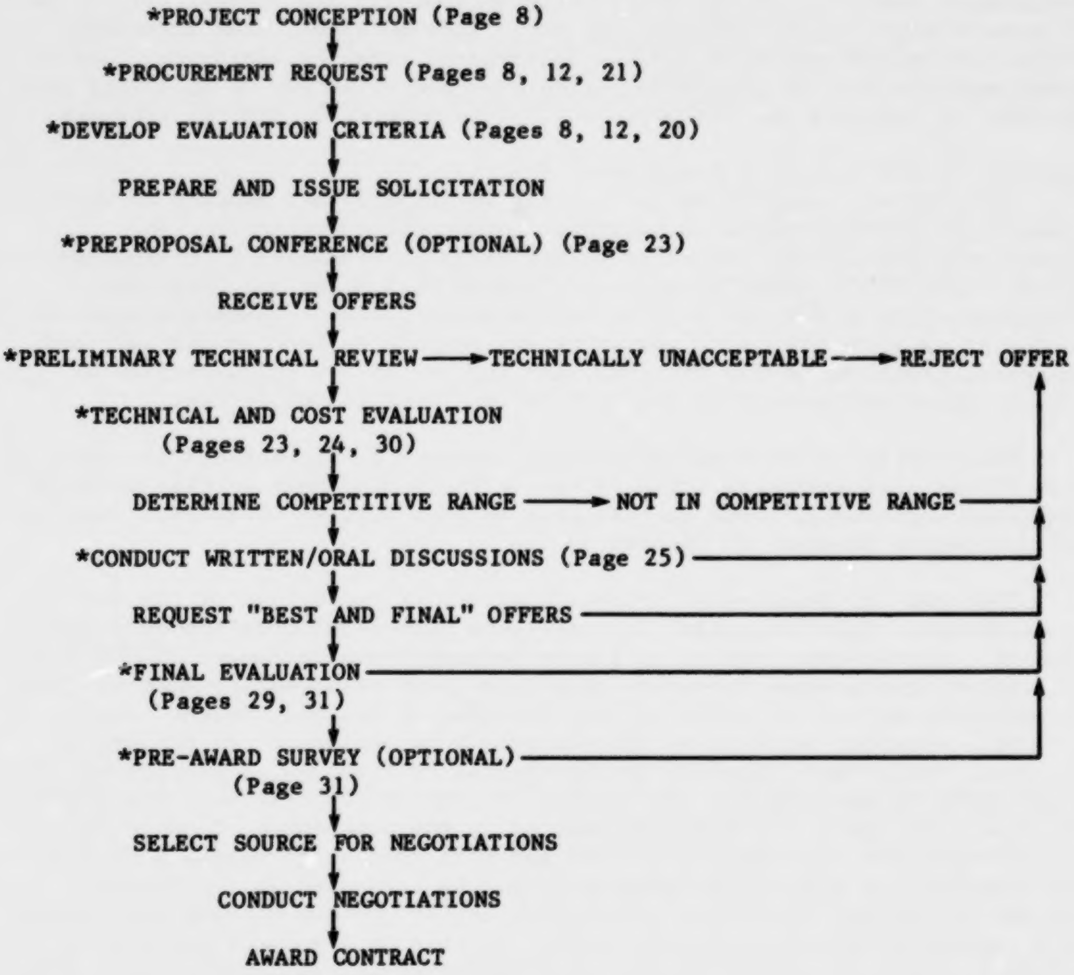
Quality assurance begins with, and is most directly controlled in, the procurement process. If the Contracting Officer and the Project Officer fail to procure high quality sampling and analytical services, then successful project accomplishment is seriously jeopardized from the beginning. Hence, prime emphasis must be placed on giving adequate attention to QA during procurement of sampling and analysis services in support of IERL-Ci programs.

Overview of the Contracts Procurement Process--

Many IERL-Ci research and demonstration projects are awarded on a competitive contract basis to qualified commercial contractors. The procurement process for contracts is described in Procurement Information Notice (PIN) 77-15, which is entitled "Source Evaluation and Selection Procedures." It is EPA policy that source selection and evaluation shall be conducted in accordance with standards and procedures that insure fair and impartial treatment of all offerors, and further insure the selection of sources whose performance is expected to best meet EPA objectives.

The contract procurement processing sequence is illustrated in Figure 2. This figure also indicates those points in the procurement process where QA considerations should apply and the page of this section where each step in the processing sequence is discussed.

The contract procurement process begins with conception of the work to be performed. This conception is translated into a solicitation by completion of a procurement request rationale document with accompanying EPA Form No. 1900-8 (Procurement Request/Requisition). QA requirements must be clearly specified within the scope of work sections of the procurement request rationale document and must be given a proper weighting in the evaluation criteria. After advertisement for interested contractors, a Request for Proposal (RFP) is prepared for the Project Officer by the Contracts Management Division. The QA requirements delineated in the procurement request rationale document are described in the RFP and will eventually become a part of the contract. A preproposal conference may be requested by the Project Officer and called by the Contracting Officer to further discuss procurement requirements with prospective offerors. If this is the case, prospective offerors should be advised of the level of importance attached to QA. After receipt of offers, a series of technical reviews is conducted by the Technical Evaluation Panel. QA aspects must be given proper consideration during each of the technical reviews. The initial objective at this stage is to disqualify those offerors who do not propose the minimally required QA, provided the evaluation requirements have been clearly and adequately stated in the RFP. Beyond that, it is of value to rank the responsive offerors with respect to QA and all other technical aspects as stated in the proposal evaluation criteria. A checklist has been provided in these guidelines to assist in the ranking of offerors in this regard. The Technical Evaluation Panel may elect to provide performance test samples to the responsive offerors if this provision was stated in the RFP.


*PROJECT CONCEPTION (Page 8)
*PROCUREMENT REQUEST (Pages 8, 12, 21)
*DEVELOP EVALUATION CRITERIA (Pages 8, 12, 20)
PREPARE AND ISSUE SOLICITATION
*PREPROPOSAL CONFERENCE (OPTIONAL) (Page 23)
RECEIVE OFFERS
*PRELIMINARY TECHNICAL REVIEW
TECHNICALLY UNACCEPTABLE
REJECT OFFER
*TECHNICAL AND COST EVALUATION (Pages 23, 24, 30)
DETERMINE COMPETITIVE RANGE
NOT IN COMPETITIVE RANGE
*CONDUCT WRITTEN/ORAL DISCUSSIONS (Page 25)
REQUEST "BEST AND FINAL" OFFERS
*FINAL EVALUATION (Pages 29, 31)
*PRE-AWARD SURVEY (OPTIONAL) (Page 31)
SELECT SOURCE FOR NEGOTIATIONS
CONDUCT NEGOTIATIONS
AWARD CONTRACT

*QA considerations are important at these points in the process.

Figure 2. Processing sequence for contract source evaluation and selection.

Qualified offerors are identified on the basis of technical review. A business and cost evaluation of the offer is conducted at the same time. Since the cost to conduct an effort requiring sampling and analysis tasks is clearly affected by the QA methods employed, QA must be given proper consideration in the business evaluation. The costs of the necessary QA program for the sampling and analysis aspects are a legitimate charge to the project, and the costs are covered in the contract by EPA. After both the technical and business evaluation, the competitive range is established, and offerors are notified by the Contracting Officer whether or not they are in the competitive range.

According to agency regulations, written or oral discussions must be conducted with all responsive offerors who have submitted proposals within the competitive range. During these discussions, any uncertainties should be resolved concerning the offeror's compliance with the specified QA aspects of the effort. Following the receipt of "best and final" offers, it is frequently of value to conduct a pre-award survey of the offerors in the final competitive range. The pre-award survey provides an ideal opportunity for the Project Officer to gain an in-depth knowledge of the QA programs of the various offerors. For this reason, pre-award surveys should be encouraged for projects in which sampling and analysis constitute a large portion of the effort or are, in themselves, a major cost factor.

After "best and final" offers are received, a final evaluation, which may include a pre-award survey, is conducted, and a determination made of the source to be selected for negotiations. Negotiations are conducted, and the business evaluation is completed by performance of a financial audit or a cost advisory. When this step is successfully concluded, a contract is awarded to the successful bidder.

Overview of the Research and Demonstration Grant or Cooperative Agreement Procurement Process--

IERL-Ci research and demonstration projects are also conducted by the granting of funds to qualified research institutions for the entire program or for various portions of a program. The Project Officer's role in the procurement process for research and demonstration grants is described in the "EPA Project Officer's Guide (Research & Demonstration Grants)" (EPA, undated). The procurement process for research and demonstration grants is entirely different than for contracts. Unlike contractors, grantees are not normally selected on a competitive basis. The assigned Project Officer or the prospective Project Officer for a research and demonstration grant has a much more interactive role with the prospective grantee. He, in fact, may be the principal EPA contact with the prospective grantee during the application and processing stages, whereas this is specifically prohibited for contracts. He has major authority in the selection of a grantee and the awarding of the grant. Assistance is provided to the Project Officer by the Grants Administration Division (GAD) in Headquarters. A technician in the Grants Operations Branch of GAD is assigned to assist the Project Officer with administrative matters during the procurement process and throughout the life of the project.

The processing sequence for research and demonstration grants and cooperative agreements is shown in Figure 3. QA considerations enter the procurement process during preparation and technical review of the application.

After preliminary discussions with the appropriate program office, a research or demonstration grant application is normally submitted in an area of particular interest to or expertise of the applicant. The Project Officer may advise the applicant in the preparation of the formal grant application. One objective at this point in the process is to assure that the applicant gives adequate regard to the QA aspects of his work. The applicant should be provided guidance on the QA requirements of the Laboratory (IERL-Ci) and, in his application, should commit to meeting these requirements as stated in Section 2, "Quality Assurance Guidelines for Monitoring of Projects Requiring Sampling and Analysis."

QA aspects should be given an appropriate and equitable level of attention during the technical review of grant applications. Even though the evaluation criteria are more subjective than for contracts, similar QA criteria can be used for guidance as discussed in this section under "QA Evaluation of Grant Applications" on page 28. Pre-award surveys of prospective grantees may be conducted and, in fact, are strongly encouraged when possible. Performance testing may also be used to evaluate an applicant.

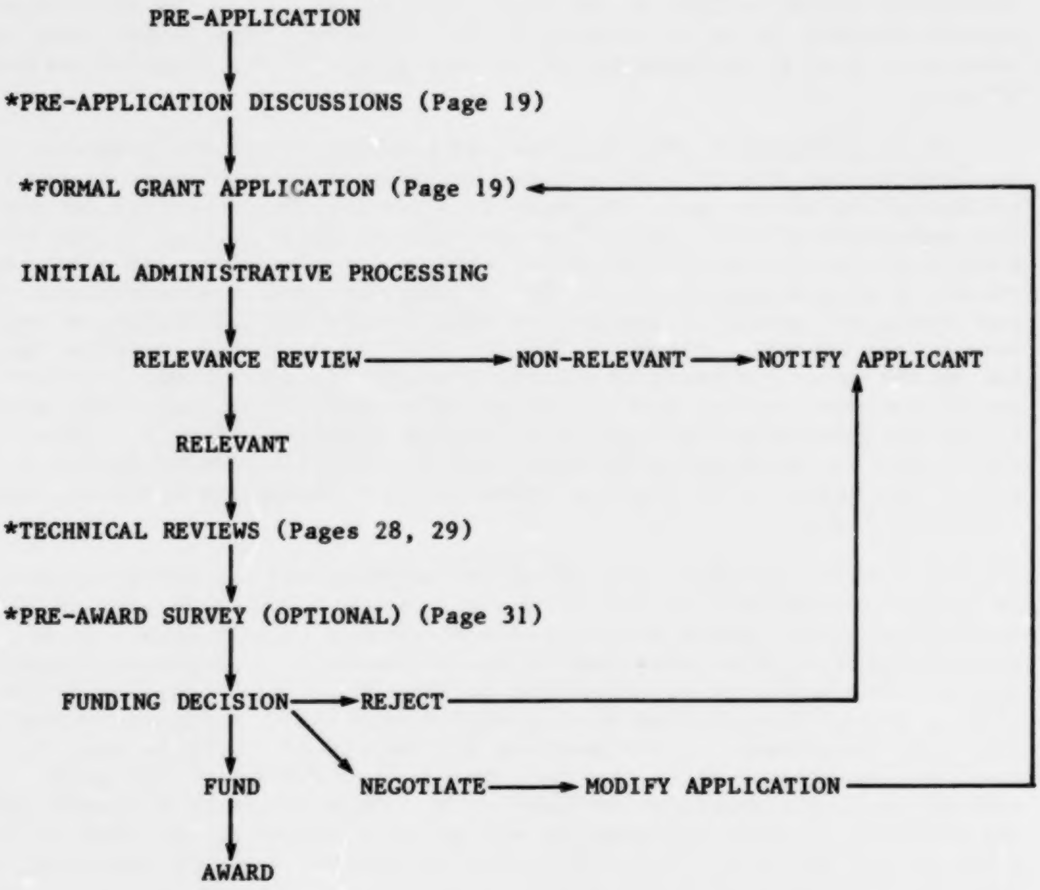
During the decision process on whether or not to fund a grant, negotiations with the applicant may occur. If this is the case, the Project Officer works with the applicant to modify the proposal to meet the objectives of the program office. For example, if the proposed QA procedures were found to be inadequate or inappropriate, they may be adjusted by the applicant at this time.

QA CRITERIA IN PROJECT CONCEPTION AND SOLICITATION

Project Conception (Contracts)

QA must be given proper consideration in the conceptual stages of a project. Project sampling and analysis programs may range from non-existent to greatly important for the outcome of the work, regardless of the magnitude of the sampling and analytical effort. Correspondingly, the resulting data may be ancillary to the final outcome of the effort or of vital importance. Since cost effectiveness is another criterion to be considered, and since QA programs affect cost, judgment must be used in stipulating QA requirements. It is not categorically true that the more QA applied to a given sampling and analysis program, the more effective that program will be.

The level of importance ascribed to QA in any given project must be clearly transmitted through the Contracting Officer to those organizations that will propose to accomplish the work. QA requirements are to be


PRE-APPLICATION
*PRE-APPLICATION DISCUSSIONS (Page 19)
*FORMAL GRANT APPLICATION (Page 19)
INITIAL ADMINISTRATIVE PROCESSING
RELEVANCE REVIEW
NON-RELEVANT
NOTIFY APPLICANT
RELEVANT
*TECHNICAL REVIEWS (Pages 28, 29)
*PRE-AWARD SURVEY (OPTIONAL) (Page 31)
FUNDING DECISION
REJECT
FUND
NEGOTIATE
MODIFY APPLICATION
AWARD

*QA considerations are important at these points in the process.

Figure 3. Processing sequence for research and demonstration grants and cooperative agreements.

specified in the procurement request rationale document with accompanying EPA Form 1900-8 (Procurement Request/Requisition) and, ultimately, in the RFP package prepared by the Contracting Officer. The QA requirements must be adequately defined either in the scope of work section of the procurement request document or by attachments to this document. The proper level of importance must be assigned in the scoring system of the proposal evaluation criteria.

It is recommended that specific evaluation criteria and points be assigned to the offeror's QA program when sampling and analysis is required to accomplish the project. Guidance is provided in this section for assigning evaluation points. Many other criteria routinely applied in the evaluation of proposals are closely allied with QA considerations and should be viewed in this regard, however. For example, proposal evaluation criteria and points are generally assigned to demonstrated qualifications and experience of key project personnel. The availability of highly competent personnel on the offeror's staff is clearly a benefit to overall QA. Furthermore, an offeror must have or must obtain suitable sampling equipment and analytical instrumentation in order to accomplish high quality work. Since facilities and personnel qualifications are generally awarded evaluation points, QA aspects will normally enter into the evaluation criteria under several headings.

As general guidance, when QA of the sampling and analytical program is of critical importance to the success of a project, up to 30 percent of the evaluation points should be assigned specifically to this area. If an offeror fails to show competence in QA, he should be technically disqualified overall and should not be privileged to receive further technical review. An offeror may be disqualified by this method only if it is clearly stated in the RFP. Conversely, if the sampling and analytical effort is only of ancillary importance to the project, as few as 5 percent of the total evaluation points should be assigned to QA. This should be a minimum point assignment. If QA of the sampling and analysis effort is not worth at least 5 percent of the total technical evaluation points, then the necessity of the sampling and analysis effort should be questioned. The individual preparing the procurement request must make a judgment of the relative importance of QA efforts in order to assign the proper weighting within the range of 5 to 30 percent of the total technical evaluation points. The point range should be adjusted so as to disqualify offers where the proposed QA program is totally inadequate for the purposes and objectives of the project.

The relative importance of QA efforts should be assessed by determination of the ultimate use of the sampling and analytical data, the methods required, and the magnitude of the effort. Table 1 is provided to assist the Project Officer, who prepares the procurement request, in assigning technical evaluation points for the QA program offered by each RFP respondent. The point ranges in Table 1 are broad and overlapping. The Project Officer must, therefore, use his judgment in selecting the appropriate point assignment, taking into consideration all other evaluation criteria and technical aspects of the project.

TABLE 1. ASSIGNMENT OF EVALUATION POINTS FOR QA

Relative importance of sampling and analysis data	Suggested assignment of points (% of total)
Sampling and analysis data of only ancillary importance to the overall objectives of the project or sampling and analysis are only a very small portion of the total effort	5 (minimum)
Semi-quantitative data is adequate	5-10
Data will be used for screening purposes and will probably be validated by other data	10-15
Data will be used to make economically-important decisions on equipment design	15-25
Sampling and analysis is a substantial portion of the total effort	20-25
Data will be used for regulatory support	25-30
All data will clearly be subject to legal scrutiny and defense	30

Table 2 may be of further assistance to the Project Officer. This table is a checklist that can be used to assess the relative level of importance of the sampling and analysis QA program by rating the requirements of the program based on the questions listed. Ten questions are provided, with a possible total score of 30 points. The Project Officer should rate his response to each question and add the total points. The total point value placed on these responses corresponds to the suggested approximate assignment of points in the technical evaluation criteria, on the basis of the percent of the maximum evaluation point score for all technical criteria. The suggested point assignment arrived at by use of Table 2 should also correspond with the appropriate ranges suggested in Table 1. Hence, either approach can be used to determine the approximate value of technical evaluation points for Quality Assurance.

Example: Requirement to demonstrate the feasibility of a new type of waste treatment process in the removal of numerous contaminants from wastewaters produced by shale oil recovery processes. Bench scale tests have shown the treatment process works exceptionally well, and it has been decided by EPA to fund a pilot plant study. If the results from the pilot treatment plant prove successful, further scale-up will be attempted, and the shale oil industry may be required to install this type of treatment facility at each location at a cost of millions of dollars. The approved funding for this contract is $450,000, and the Project Officer estimates that $50,000 will be expended for analytical laboratory services. Sampling and analysis will be conducted of wastewaters typical of the shale oil industry during pilot plant tests.

The Project Officer, in this example, may evaluate the importance of sampling and analytical QA as shown in Table 3. A total of 23 points has been assigned. Hence, the Project Officer should assign points within the range of 20-25 percent of the total evaluation points to sampling and analytical QA.

Alternatively, the Project Officer may have drawn the same conclusion by assessing the evaluation points in Table 1. Since the data clearly will be used to make economically-important decisions and to design major equipment, the point total for QA should lie in the high end of the 15-25 percent range.

Once the proper relative weighting for QA is established, the evaluation criteria for this solicitation may appear as shown in Table 4. It should also be stated in the RFP that a bidder must show adequate qualifications in each Quality Assurance area to be qualified for consideration with regard to the other technical areas.

Contract Solicitation

The Contracting Officer will prepare a Request for Proposal (RFP) package based on the information submitted in the procurement request rationale document with accompanying EPA Form 1900-8 (Procurement Request/Requisition).

TABLE 2. EVALUATION OF THE IMPORTANCE OF SAMPLING AND ANALYSIS QA

Evaluation considerations	Low 0 (<10%)	1 (10-50%)	2 (50-90%)	High 3 (>90%)
What percent of the total project effort is related to sampling and analysis?	0	1	2	3
What is the probability the resulting data or conclusions drawn from the data will be subject to legal scrutiny?	0	1	2	3
What is the probability the data will be used to make economically-important or policy decisions?	0	1	2	3
What is the likelihood the data will be used to set compliance standards or performance standards?	0	1	2	3
What is the probability the data will be used for equipment or facilities design?	0	1	2	3
What possibility exists that the data will be used for regulatory support functions?	0	1	2	3
Is the data to be used only for screening purposes or for validation purposes? If for screening only, assign relatively low importance (0 to 1). If for validation, assign relatively high importance (2 or 3).	0	1	2	3
Is semi-quantitative data adequate for the needs of the project, or is a high degree of accuracy required? Assign importance relative to the degree of quantitative accuracy required: 0 if semi-quantitative data is adequate; 3 if the highest possible accuracy is necessary.	0	1	2	3

(continued)

TABLE 2 (continued)

Evaluation considerations	Low 0 (<10%)	1 (10-50%)	2 (50-90%)	High 3 (>90%)
Are a variety of sampling and analytical methods required, including complex methods? Assign relative importance, compared to other IERL-Ci projects, based on the degree of variety and complexity of the methods required.	0	1	2	3
What is the possibility that the sampling and analytical data will be included in a consolidated data base?	0	1	2	3

TOTAL POINTS

Approximate percent of proposal technical evaluation points to be assigned to QA procedures.

TABLE 3. EXAMPLE OF THE ASSESSMENT OF THE IMPORTANCE OF SAMPLING AND ANALYSIS QA

Evaluation considerations	Low 0 (<10%)	1 (10-50%)	2 (50-90%)	High 3 (>90%)
What percent of the total project effort is related to sampling and analysis?	0	[✓ 1]	2	3
What is the probability the resulting data or conclusions drawn from the data will be subject to legal scrutiny?	0	1	[✓ 2]	3
What is the probability the data will be used to make economically-important or policy decisions?	0	1	2	[✓ 3]
What is the likelihood the data will be used to set compliance standards or performance standards?	0	1	[✓ 2]	3
What is the probability the data will be used for equipment or facilities design?	0	1	2	[✓ 3]
What possibility exists that the data will be used for regulatory support functions?	0	[✓ 1]	2	3
Is the data to be used only for screening purposes or for validation purposes? If for screening only, assign relatively low importance (0 to 1). If for validation, assign relatively high importance (2 or 3).	0	1	2	[✓ 3]
Is semi-quantitative data adequate for the needs of the project, or is a high degree of accuracy required? Assign importance relative to the degree of quantitative accuracy required: 0 if semi-quantitative accuracy required: 0 if semi-quantitative data is adequate; 3 if the highest possible accuracy is necessary.	0	1	2	[✓ 3]

(continued)

TABLE 3 (continued)

Evaluation considerations	Low 0 (<10%)	1 (10-50%)	2 (50-90%)	High 3 (>90%)
Are a variety of sampling and analytical methods required, including complex methods? Assign relative importance, compared to other IERL-Ci projects, based on the degree of variety and complexity of the methods required.	0	1	2	[✓ 3]
What is the possibility that the sampling and analytical data will be included in a consolidated data base?	0	1	[✓ 2]	3
	TOTAL POINTS		$\boxed{23}$	
	Approximate percent of proposal technical evaluation points to be assigned to QA procedures.			

TABLE 4. EXAMPLE TECHNICAL EVALUATION CRITERIA
INCORPORATING QUALITY ASSURANCE REQUIREMENTS

Evaluation criteria		Numerical weight	
I.	Adequacy of the Technical Proposal	60	
	a. Logic of approach to the study		20
	b. Proposed pilot plant design		20
	c. Presentation of findings		20
II.	Project Management	50	
	a. Previous experience the Project Manager has had in this type of effort		15
	b. Company resources available to the Project Manager		25
	c. Project management organization and plan		10
III.	Quality Assurance	50	
	a. Quality assurance management policy/ written procedures		10
	b. Quality assurance procedures for sampling		15
	c. Quality assurance procedures for analysis		15
	d. Quality assurance procedures for data management		10
IV.	Personnel Qualifications	40	
	a. Technical experience of the principal project staff related to the project		20
	b. Educational background of principal project staff		20
	TOTAL	200	

The RFP must be written in such a manner as to elicit adequate information from the offerors so the Technical Evaluation Panel can evaluate each offeror's technical proposal as well as the level of QA. In addition, the evaluation criteria must be clearly stated so that all offerors will attach the appropriate level of importance to QA aspects of the effort.

There are two conceptual approaches to defining QA requirements in the RFP. One is to state clearly and unequivocally in the scope of work section the QA and QC steps required of the contractor. It may be stated, for example, that all samples are to be collected in duplicate using a specified technique and that certain analytical precision must be achieved and demonstrated. Another approach is to state clearly that QA and QC are of importance and that the offeror is to explain his proposed procedures. Either approach is acceptable, but both have shortcomings.

If the required QA and QC steps are specifically delineated, it is likely that proposals will be submitted that simply "parrot" those requirements. The offeror cannot very well do otherwise. As a result, technical evaluation of proposals is simplified and cost comparisons are more easily made. The Project Officer and the Contracting Officer will know exactly the level of QC that will be applied, since it has been specified. This approach is recommended for selection of contractors when the scope of work is clearly defined, and selection can be made on costs proposed by basically qualified bidders. It is generally impractical, however, to apply this approach to less well-defined efforts. In such cases, statements should be made as to the importance of QA to the overall success of the program, and the offeror should be free to propose QA procedures appropriate to the nature of the sampling and analytical effort. This will allow a better evaluation of the offeror's knowledge of QA procedures. The offeror should be asked to provide a description of his QA administration and procedures, to show an awareness of proper sampling and analytical techniques, or to describe his methods of documenting data quality and of handling data. The Project Officer may choose to restate the applicable questions listed in Table 2 as statements of fact so that the offeror will understand IERL-Ci's interest in QA on the project.

In the case of the pilot plant example previously discussed, a statement may be made in the RFP to the effect that: "The performance results of the pilot plant to be constructed and evaluated under this contract may be used, in part, to determine EPA policy on the applicability of this method of waste treatment for the shale oil industry. For this reason, considerable importance is attached to quality assurance of the sampling and analytical aspects of the scope of work. Offerors are requested to describe, in detail, their quality assurance procedures as they would apply to this program."

Specific provisions may also be used in a solicitation to define the level of QA required and to reduce the number of non-responsive proposals. Some typical provisions are as follows:

1. "If subcontractors are to be used in this effort, the prime contractor has full responsibility for quality assurance of the subcontractor's efforts as well as his own efforts."
2. "Offerors whose proposals are determined to be technically acceptable under the initial evaluation criteria stated herein shall (may) be required to demonstrate acceptable performance by analyzing not more than ____ unknown samples for ____ parameters per sample. The cost for analysis of these samples shall be at the offeror's expense. Sample analysis results shall be compared to known EPA results for scoring purposes."
3. "Split sample analysis will be required from time to time during the course of the project to validate the quality of the data. Split samples shall not exceed a maximum of one percent of the total samples analyzed."
4. "IERL-Ci has established basic quality assurance guidelines relating to the sampling and analysis required under this contract. These guidelines are attached. The successful offeror's quality assurance procedures should generally conform to these guidelines or significant deviations must be justified and approved by the Project Officer."

The Quality Assurance Officer is familiar with the applicability of typical provisions that may be used in any particular case. He should be contacted for guidance in this regard.

Project Conception and Application for Research and Demonstration Grants

As discussed previously, the Project Officer may be the key contact person between EPA and a prospective grantee. The Agency, through the Project Officer, should make sure that each applicant for grant funds receives full and impartial consideration of his application and early notification of its disposition. Although grant applications may be submitted at any time on any research and development project, EPA encourages pre-application contact, which can benefit both the applicant and the Agency by avoiding time-consuming preparation and review of applications that cannot be funded and by sharpening the focus of proposed projects in terms of EPA needs. It is the responsibility of the Project Officer to assure that grant allocations are provided only to those organizations where work of acceptable quality will be performed.

QA should be given as much consideration in the allocation of grant funding as in contracts or in-house research projects. It is somewhat more difficult, however, to accord sufficient QA consideration for grants, since competitive selection based on defined evaluation criteria is not generally practiced. The Project Officer, therefore, must assure that QA is adequately addressed in the application stages of the grant process (see Figure 3).

In those cases in which the Project Officer is involved in pre-application activities, he may be called upon to work with the applicant in the development of an adequate application that meets the requirements of EPA and falls within general EPA objectives. This would include assisting the applicant in addressing the necessary QA aspects of sampling and analysis efforts as required by IERL-Ci. It is appropriate, if possible, for the Project Officer to make site visits or otherwise assist the applicant in developing and documenting the application in accordance with available criteria for application evaluation.

When the Project Officer is involved in pre-application activities, he should provide the prospective grantee with the QA guidelines that will be used to evaluate the formal grant application. These guidelines are described on page 28. The applicant should also be made aware of IERL-Ci requirements as described in Section 2 of this document, "Quality Assurance Guidelines for Monitoring of Projects Requiring Sampling and Analysis." If an ongoing project is under consideration for further grant funding, the Project Officer can conveniently review QA requirements with the applicant at that time.

The prospective grantee's pre-application should be reviewed with regard to his proposed QA program by using essentially the same criteria for contracts. In review of the pre-application and response to the applicant, any QA shortcomings should be noted and guidance provided on the general level of QA expected. It may be of value to inform the applicant that a pre-award survey will be conducted as part of the formal grant review process and that the applicant's QA procedures will be evaluated during this survey.

Use of Performance Test Samples in Contractor/Grantee Selection

Performance test samples can be used by the Project Officer to assist in selecting qualified contractors or grantees for projects requiring analytical services. These are samples of known concentration (known only to EPA) that are provided to the prospective contractor or grantee for analysis. Analysis is conducted and the analytical results are reported within a specified time. The results are then compared with the EPA known values to determine the accuracy of the laboratory's results.

If it has been decided to use performance test samples to evaluate offerors, the IERL-Ci Quality Assurance Officer should be notified. He will arrange for delivery of the samples and evaluation of the results. The procedure for obtaining test samples is described on page 29.

Performance test samples have been prepared and made available to Project Officers by the EPA Environmental Monitoring Systems Laboratories (Cincinnati, Las Vegas, and Research Triangle Park) through the IERL-Ci Quality Assurance Officer. Reference standards can also be obtained from the National Bureau of Standards (NBS) through the IERL-Ci Quality Assurance Officer. Appendix B contains information concerning the availability of performance test samples.

Indiscriminate or excessive use of performance test samples for the evaluation of offerors is discouraged. The samples are costly to both EPA and to the offeror if he must conduct many such tests. As general guidance, performance test samples should be considered for use only when two or more of the criteria listed in Table 5 apply. Some of these criteria cannot be assessed, of course, until all responsive offers have undergone technical evaluation and have been scored according to the stated evaluation criteria. Hence, it is suggested that if the Project Officer is uncertain about the need for performance test samples when preparing the procurement request, he state the requirement for analyzing performance test samples in the RFP and choose later whether to exercise the option. This can be accomplished by inserting the following provision in the procurement request:

> "Offerors whose proposals are determined to be technically acceptable under the initial evaluation criteria stated herein shall (may) be required to demonstrate acceptable performance by analyzing not more than _____ unknown samples for _____ parameters per sample. The cost for analysis of these samples shall be at the offeror's expense. Sample analysis results shall be compared to known EPA results for scoring purposes."

The final determination of whether or not performance test samples would be of sufficient value in the assessment of offeror(s) performance to warrant their cost must be made by the Project Officer. If the Project Officer chooses to use performance test samples, it must be made clear at what point in the selection process these samples will be used. Will they be sent to all offerors, or just those in the running at the final evaluation stage? Furthermore, the proposal evaluation criteria must allow for the scoring of test results. The Project Officer is encouraged to seek the advice of the IERL-Ci Quality Assurance Officer on the proper use of performance test samples.

Cost Considerations

To complete the procurement request rationale document with accompanying EPA Form 1900-8 (Procurement Request/Requisition) for a project, the Project Officer must prepare an estimate of the anticipated cost of the required scope of work. For cost estimating, proper consideration should be given to the cost incurred for QA procedures on sampling and analysis programs. It is recommended by EPA in "Handbook for Analytical Quality Control in Water and Wastewater Laboratories" (EPA, 1979) that daily control of analytical performance in the laboratory requires approximately 15 to 20 percent of the analyst's time. The good laboratory QA program will also call for the maintenance of analytical control charts, training of personnel, the frequent analysis of performance test samples, and extensive recordkeeping. Hence, an adequate QA program will normally require a minimum of 20 percent of the total analytical budget. When sampling is required, a minimum of 10 percent of the samples should normally be collected in duplicate. Samples can be split after collection, or several aliquots can be taken from the same sample. This increases both the sampling and analytical costs by 2 to 3 percent, depending, of course, on the scope and complexity of the sampling effort.

TABLE 5. SUGGESTED CRITERIA FOR USING PERFORMANCE TEST SAMPLES FOR OFFEROR EVALUATION*

_____ The sampling and analysis effort will exceed $25,000 in value.

_____ Analytical QA is very important to the overall success of the project. See Table 2.

_____ There is some doubt concerning the performance capability of the offerors.

_____ The offeror(s) cannot provide documented results of previous performance tests.

*Assuming appropriate test samples are available (see Appendix B).

Preproposal Conference

Preproposal conferences are an optional but important part of the solicitation process for contracts. They can serve an information function similar to pre-application discussions with prospective grantees. However, they must be conducted in a fair and impartial manner that will not give any prospective offeror an unfair advantage over another. The determination to conduct a preproposal conference may be made by the Project Officer through the Contracting Officer for any of the following reasons:

1. To clarify or explain complex specifications, statements of work, or proposed contractual provisions (e.g., QA program requirements),
2. To discuss or emphasize the importance of any qualification requirements, such as QA requirements,
3. To provide additional background material to prospective offerors, such as documents that are too voluminous to include with the solicitation package, a site tour, or visits to the place of performance,
4. To respond to numerous questions of potential offerors regarding the solicitations, or
5. To comply with the request of an important segment of the industry.

If the QA aspects of the proposed research effort are particularly extensive, difficult to convey, or important to the project, the Project Officer may elect to have the Contracting Officer call a preproposal conference to provide further explanation of the QA requirements to potential offerors. The preproposal conference must be conducted in accordance with PIN 77-15. A record must be kept on the proceedings of the preproposal conference; amendments to the RFP may be necessary as a result of the conference. Proceedings of the preproposal conference may be made available to all potential offerors.

QA CRITERIA IN TECHNICAL EVALUATION OF PROPOSALS AND GRANT APPLICATIONS

Technical Evaluation of Contract Proposals

Technical evaluation of proposals must be made by using only the criteria set forth in the RFP in accordance with "Source Evaluation and Selection Procedures" (PIN 77-15). In order to assist in applying QA in the technical evaluation of proposals, the proposal evaluation checklist in Appendix A provides a mechanism for the Technical Evaluation Panel to determine if an offeror meets basic QA program requirements. This checklist describes the basic requirements for any adequate QA program for sampling and analysis. Questions on the checklist are grouped into the following four areas:

1. QA management policy and written procedures,
2. QA procedures for sampling,
3. QA procedures for analysis, and
4. QA procedures for data management.

Several questions are provided in each of these areas with which to test the offeror's proposal. The questions are weighted according to their importance to a basic QA program. Proper use of this checklist when evaluating proposals should allow the Technical Evaluation Panel to identify organizations that do not offer an acceptable level of QA and those that do. Furthermore, the checklist should assist in the technical ranking of offerors who meet and surpass the basic QA program requirements.

QA Evaluation Criteria and Scoring Procedures for Contracts

The technical reviewers should evaluate each proposal with respect to the offeror's demonstrated understanding of the basic requirements of a QA program. Assuming the guidelines for project conception and solicitation on page 10 have been followed in preparation of the procurement request, and it has been indicated in the RFP that QA is important to the technical reviewers, then they can expect adequate discussion of the proposed QA program from responsive offerors. Each proposal should be evaluated with the checklist (see Appendix A). This checklist can be copied and used by the Technical Evaluation Panel. The following scoring plan (PIN 77-15) should be used:

SCORING PLAN

Scoring Value	Percent of Available Points	Evaluation
0	0	Not addressed in the offer.
1	20	Addressed, but totally deficient.
2a	40	Deficient, but appears to be capable of improvements to adequate or better without adopting a new approach.
2b	--	Appears to be deficient; however, final scores will be determined subsequent to written questions and/or oral discussions.
3	60	Adequate; overall it meets the specifications.
4	80	Good; has some superior features.
5	100	Generally superior in most features.

The relationship of the scoring plan to written or oral discussions and to subsequent negotiations is as follows:

1. Value of "0," "1," or "2a"--The element or sub-element clearly is deficient and is not to be questioned or discussed during written or oral discussion. Such values are solely for the purpose of scoring, ranking, and determination of the technical competitive range. If, however, the offer attains an overall score, because of other factors, that places it in a sufficiently high position to be selected for negotiations, the offeror shall be allowed to correct these deficiencies during negotiations.

2. Value of "2b"--The element or sub-element contains uncertainties which must be resolved before the offer is fully understood. Such uncertainties are to be resolved during written or oral discussions, and the offer is to be given a final score that is based on the offeror's clarifications.

3. Values of "3", "4," or "5"--The element or sub-element is fully understood and there is no need for clarification by the offeror. However, discussions involving any such elements or sub-elements are not precluded.

Each offeror's proposal is evaluated in the four QA areas which have been identified in the technical evaluation criteria included in the RFP (see Table 4). In the area of QA procedures for analysis, one of the criteria is an evaluation of the use of standard analytical methods (a listing of these methods is presented in Appendix C).

If there is insufficient information provided in the proposal to assess any particular question(s) in the checklist, the reviewer should assign a score of 2b on that question. Those questions assigned a value of 2b should be specifically addressed during subsequent written or oral discussions with technically competitive offerors in accordance with PIN 77-15 procedures.

Example: To return to the previous example of a wastewater treatment pilot plant for the shale oil industry, one offeror may have scored as shown in Figure 4 on QA procedures for data management, one sub-element of the proposal evaluation criteria. This offeror scored a total of 50 out of a possible 75 points on this sub-element. Hence, he was awarded 66 percent of the total points. Since this is closest to 60 percent of the points available for this sub-element, this offeror is assigned a score of 3 for sub-element IIId (Table 4) of the proposal evaluation criteria. This sub-element is weighted according to the original proposal evaluation criteria. The offeror, therefore, may have achieved a total technical score as shown in Figure 5. In this way, the scoring of the QA evaluation criteria checklist is integrated with the proposal evaluation criteria.

This offeror was awarded a 2b on one question on the checklist (Figure 4). It was not clear in the proposal whether data and other records associated with the project would be retained for a minimum of three years. This point should be resolved during written or oral discussions with this offeror if he is in the technical competitive range.

Written/Oral Discussions with Offerors

Public law requires written or oral discussions in negotiated procurements with all responsible offerors who submit proposals within the competitive range (PIN 77-15). The Project Officer and the Contracting Officer will participate in these discussions. The purposes of these discussions are to:

QUALITY ASSURANCE EVALUATION CRITERIA CHECKLIST FOR PROPOSALS OFFERING SAMPLING AND ANALYSIS SERVICES

Criteria	Scoring Value	x	Numerical Weight	=	Individual Score
D. Quality assurance procedures for data management.					
1d. Does the offeror possess appropriate data handling, processing, and retrieval capabilities?	4	x	3	=	12
2d. Will QC data (e.g., standard curves, duplicate results, spike sample results) be maintained and be accessible to the Project Officer?	3	x	3	=	9
3d. Does the organization routinely maintain analytical performance records such as quality control charts?	3	x	2	=	6
4d. Are all laboratory results and QC data reviewed by laboratory supervisory personnel?	4	x	3	=	12
5d. Are all data and records retained for a minimum of 3 years?	2b	x	1	=	2
6d. Are field notebooks used to record sampling and engineering data (e.g., sample number, date/time of collection, flow, operating conditions, etc.)?	3	x	3	=	9

Total Score for Sub-Element D 50

Maximum Possible Score 75

Percent of maximum possible score awarded for sub-element D (circle closest value).

0% 20% 40% — [✓ 60%] 80% 100%

Score for this sub-element of the proposal evaluation criteria (circle corresponding value).

0 1 2a 2b [✓ 3] 4 5

Figure 4. Example use of QA evaluation criteria checklist for scoring proposals.

Evaluation Criteria		Numerical Weight		Scoring Plan	Individual Score
I.	Adequacy of the Technical Proposal	60			40
	a. Logic of approach to the study		20	3	12
	b. Proposed pilot plant design		20	2b	8
	c. Presentation of findings		20	5	20
II.	Project Management	50			37
	a. Previous experience the Project Manager has had in this type of effort		15	2	6
	b. Company resources available to the Project Manager		25	5	25
	c. Project management organization and plan		10	3	6
III.	Quality Assurance	50			35
	a. Quality assurance management policy/written procedures		10	4	8
	b. Quality assurance procedures for sampling		15	3	9
	c. Quality assurance procedures for analysis		15	4	12
	d. Quality assurance procedures for data management		10	3	6
IV.	Personnel Qualifications	40			28
	a. Technical experience of the principal project staff related to the project		20	4	16
	b. Educational background of principal project staff		20	3	12
				TOTAL SCORE	140

Figure 5. Example of technical evaluation scoring system.

1. Provide offerors an opportunity to further explain their offers,
2. Afford the Contracting Officer and the Project Officer an opportunity to understand fully what is being offered,
3. Arrive at preliminary agreements regarding price, cost, performance, contract terms and conditions, and
4. Resolve minor technicalities in offers.

This is the point in the procurement process where any of the offerors may be asked to clarify their proposed QA procedures. If, during the course of the scoring of an offeror's proposal, a score of 2b is given for any of the QA Evaluation Criteria Checklist questions, clarification or more information should be requested during the written or oral discussions. The response to these questions will be used in the final review (Figure 4). Upon conclusion of the written or oral discussions, the Project Officer and the Contracting Officer will determine of whom a "best and final" offer is to be requested.

QA Evaluation of Grant Applications

If a grant application is judged relevant to the IERL-Ci program mission and funding can be provided, then arrangements are made for technical reviews. A minimum of one intramural and two extramural reviews of technical and scientific merit are required for new grant applications.

The technical evaluation criteria for research and demonstration grant applications are much more subjective than those for competitive procurements. There is no standard set of criteria that can apply in each case because of the diversity of the programs, the sampling and analytical requirements, and the organizations performing the work. This should not, however, be used as an excuse for failing to recognize the importance of a sound QA program.

When the project involves sampling and analysis activities, each technical reviewer should be requested to address specifically the applicant's proposed QA program or plan during his evaluation of the technical and scientific merit of the proposal. To aid project officers and reviewers in this regard, the checklist in Appendix A should be used. It is not necessary, however, to score the checklist results since grants are not awarded on a competitive basis. For grants, the scoring plan should be disregarded and each checklist question answered in the affirmative or negative. The Project Officer should assure that a copy of this checklist, which may be reproduced from Appendix A, is forwarded along with the grant application in the review package provided to each reviewer. The transmittal letter that accompanies the review package should request that the reviewer consider use of this checklist to evaluate the technical and scientific merit of the proposed study. Each reviewer's comments should be used to support the funding decision (see Figure 3) and/or to improve the technical or scientific merit of the proposed study.

Evaluation of Performance Test Samples

If it has been decided to use performance test samples to help in selection of a contractor, in accordance with the guidelines provided on page 20, then they must be provided to all offerors whose proposals are technically acceptable and are in the competitive range. Select those performance test samples from the list of available samples, Appendix B, that evaluate analytical capabilities that will be required on the project. Inform the IERL-Ci Quality Assurance Officer of your needs for performance test samples, and he will arrange to have them sent to the competitive offerors. Instructions will be provided for return of the analytical results to the Quality Assurance Officer.

Allow each offeror sufficient time to receive the test samples from EPA, to conduct the analyses, and to report the results along with his normal laboratory routine. A minimum of one month will normally be required. It may be advisable to ask the offeror(s) what period of time he requires to complete the analyses and report the results. The IERL-Ci Quality Assurance Officer can also provide recommendations in this regard. If insufficient analysis time is allotted, special handling of these samples will be required, and this would result in an increased cost to the offeror(s).

After receiving all results from responsive offerors within the specified period of time, the Quality Assurance Officer will assist in interpreting the results.

Performance test samples become part of the technical evaluation and may be discussed during post-award debriefings. The Project Officer is to inform the Contracting Officer of the results of the performance test sample analysis, and the Contracting Officer will convey the results to the offeror(s). Each parameter should be defined as acceptable or unacceptable, and the evaluation criteria should be provided. Any unacceptable results should be described as either high or low, as appropriate, since true values cannot be provided. Since offerors must bear the cost of performance test sample analysis, they should be informed of their performance as soon as possible so that any necessary corrective action may be taken.

Performance test samples can be used to evaluate research and demonstration grant applicants in the same manner as prospective contractors.

EVALUATION OF PREVIOUS PERFORMANCE HISTORY

One indication of the probability of successful project accomplishment on the part of a prospective contractor or grantee is his performance record on previous projects. The offeror is required to list current and recently completed EPA contracts in his proposal. The interested Project Officer can request a list of the Project Officers on these contracts. As part of the technical evaluation of the offerors, Project Officers on other government projects can be contacted. These Project Officers could provide useful information concerning their level of satisfaction with the prospective contractor's sampling and analytical QA, if the project calls for these services. Likewise, a prospective grantee may be evaluated by contacting Project Officers on past or present grants he holds.

If the offeror has performed on a previous EPA contract, the Contracting Officer should have access to records regarding his performance. If the offeror has performed past work for other agencies of the government, the Contracting Officer may be able to obtain this information from the Contractor Relations Section, Contracts Management Division, Washington, D.C., 20460.

Each Project Officer is required to complete a Project Officer's Evaluation of Contractor Performance (EPA Form 1900-27) at the conclusion of a contract. Review of this form may provide valuable information to help assess the likelihood that a given offeror may perform well on your project. Several points must be remembered, however, when reviewing these forms reporting on past project performance:

1. The work performed should be similar to that proposed in the current scope of work,
2. Only performance in the recent past should be considered, since changes in the organization may invalidate previous performance information, and
3. Past performance, whether good or poor, may not be used as pass/fail criteria.

COST EVALUATION

The cost evaluation of a proposal is conducted by the Contracting Officer concurrently with the evaluation of the technical aspects by the Project Officer.

The Contracting Officer reviews each element of the offeror's business and management proposal for the following:

1. Reasonableness of price or estimated cost with respect to the requirement,
2. Investigation of unreasonably high or low cost elements,
3. Evaluation of the proposed management structure to be utilized for performance,
4. Indirect cost management, and
5. Analysis of manhours and materials.

The Project Officer is notified of those cost proposals considered to be acceptable and receives copies of the cost proposals to be compared against those offerors' technical proposals which have been judged to be within the acceptable technical range.

The Project Officer compares the cost and business proposals and decides which proposals merit additional consideration. QA cost considerations are presented on page 21.

After a thorough review of the 5 specific items mentioned previously, the Contracting Officer, with input from the Project Officer, makes the decision as to which cost proposals are considered to be in the acceptable range.

BEST AND FINAL OFFER EVALUATION

The evaluation of cost and technical proposals results in the selection of candidates who are asked to present a best and final offer. Negotiations are begun with the successful offeror(s) based on their "best and final" offers. The funding decision serves the same purpose for non-competitive grants. The extent of this final evaluation is determined by the Contracting Officer. All scores of 2b must be reassessed and rescored. The Project Officer may choose to conduct a pre-award survey of one or more of the offerors following the "best and final" offer evaluation. The Project Officer may be accompanied by the Contracting Officer during pre-award surveys.

Following completion of final evaluation, negotiations, and award, all records pertaining to the selection process (e.g., checklists) are provided to and retained by the Contracting Officer. The contractor or the grantee should be informed upon award that quality assurance procedures will be monitored throughout the life of the project by the Project Officer. (Section 2 of this document, "Quality Assurance Guidelines for Monitoring Projects Requiring Sampling and Analysis", describes project monitoring procedures.)

PRE-AWARD SURVEYS

It was stated on page 25 that written or oral discussions with each of the offerors who submitted proposals in the competitive range were mandatory. At the option of the Contracting Officer and the Project Officer, these discussions may include a visit to the prospective contractor's or grantee's facilities, but only after the "best and final" offer has been received. Such visits offer an excellent way to assess thoroughly an offeror's QA program and awareness. Some of the criteria that may justify a pre-award survey are listed in Table 6.

Pre-award surveys must be conducted in such a manner as to avoid giving an unfair advantage to any offeror on competitive procurements. All communications must be conducted in accordance with the guidelines stated in PIN 77-15. The Contracting Officer must accompany the Project Officer on pre-award surveys. At the request of the Project Officer, the IERL-Ci Quality Assurance Officer or an IERL-Ci contractor may participate in the pre-award survey.

The pre-award survey is a good time to resolve any questions that remain unresolved from the quality assurance evaluation criteria checklist. Any scores of 2b on this checklist should, in particular, be addressed in the pre-award survey if they have not been resolved in previous discussions. Each of the QA criteria should be rescored during or after the visit. Table 7 is a suggested agenda for a pre-award survey.

TABLE 6. CRITERIA FOR CONDUCTING A PRE-AWARD SURVEY*

_____ After technical evaluation of the proposal(s), there remain sufficient unresolved questions to merit a face-to-face meeting with the prospective contractor or grantee after submission of the "best and final" offer.

_____ A greater in-depth knowledge is required of the prospective contractor's or grantee's QA procedures.

_____ An inspection of the prospective contractor's or grantee's facilities would assist in the evaluation process after submission of the "best and final" offer.

_____ Face-to-face discussions with key project personnel would assist in the evaluation process.

_____ Past performance history of the prospective contractor or grantee has not been particularly good; however, there is reason to believe improvements have been made.

_____ A decision among the top contenders cannot be conclusively justified without further information.

*If any of these questions are answered in the affirmative, then a pre-award survey should be strongly considered.

A pre-award survey may also precede the funding decision for a research and demonstration grant application. The Project Officer is encouraged to invite the participation of the IERL-Ci Quality Assurance Officer in this survey. During the survey, any unresolved questions that remain from the recommended quality assurance criteria discussed on page 28 pertaining to the evaluation of grant applications should be addressed and settled.

TABLE 7. SUGGESTED PRE-AWARD SURVEY AGENDA

A. Discussions with key project personnel

   1. Project management organization
   2. Administrative management/project management interface
   3. Approach to accomplishing the scope of work
   4. QA aspects of the program
   5. Establish communications

B. Review prospective contractor's/grantee's facilities

   1. Discuss equipment/instrumentation that will be used
   2. Evaluate overall appearance, resources, and scope of capabilities

C. Review prospective contractor's/grantee's QA program

   1. Ask for copy of written QA plan
   2. Discuss how this plan will apply to the project under discussion
   3. Review QA documentation on typical work
   4. Discuss QA procedures for the sampling effort*
   5. Discuss QA procedures for analysis*

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*To assist in this regard, the Project Officer is encouraged to use the QA Evaluation Criteria Checklist (Appendix A) and the QA Audit Checklist (Appendix I).

SECTION 2

QUALITY ASSURANCE GUIDELINES FOR MONITORING OF PROJECTS REQUIRING SAMPLING AND ANALYSIS

INTRODUCTION

These guidelines have been prepared to assist the IERL-Ci Project Officer in directing contractor's efforts and in overseeing research and demonstration grants which incorporate sampling and analysis activities. The Project Officer's QA responsibilities are described beginning on page 37 for both contracts and grants. These responsibilities begin with project initiation and extend through the monitoring of all sampling and analysis activities. The Project Officer's QA responsibilities do not end with the field and the laboratory work, however; they continue through close review of the results of the sampling and analysis program, the interpretation of the quality control data, and the use to which the sampling and analytical data are applied, including the conclusions and recommendations of the project.

There are three basic foundations upon which project quality assurance is built. They are:

1. The contractor's or grantee's QA program,
2. The Project QA Plan, and
3. QA monitoring of project activities and results.

These foundations of project quality assurance are depicted in Figure 6, along with the elements of each.

All contractors and grantees should have a QA program. This QA program describes the in-house procedures used by the contractor/grantee to guarantee, to the extent possible, the quality of his work. The elements of a suitable and acceptable QA program are described under Contractor's/Grantee's QA Program on page 43. A checklist is provided in Appendix D to assist the Project Officer in reviewing a contractor's or a grantee's QA program. This checklist can also be used to help the contractor or the grantee to develop an acceptable QA program if his present program does not meet IERL-Ci requirements.

Each project should begin by preparation of a Project Work Plan which describes how the effort will be accomplished. A key part of any Project Work Plan is a discussion of the sampling and analysis program and the

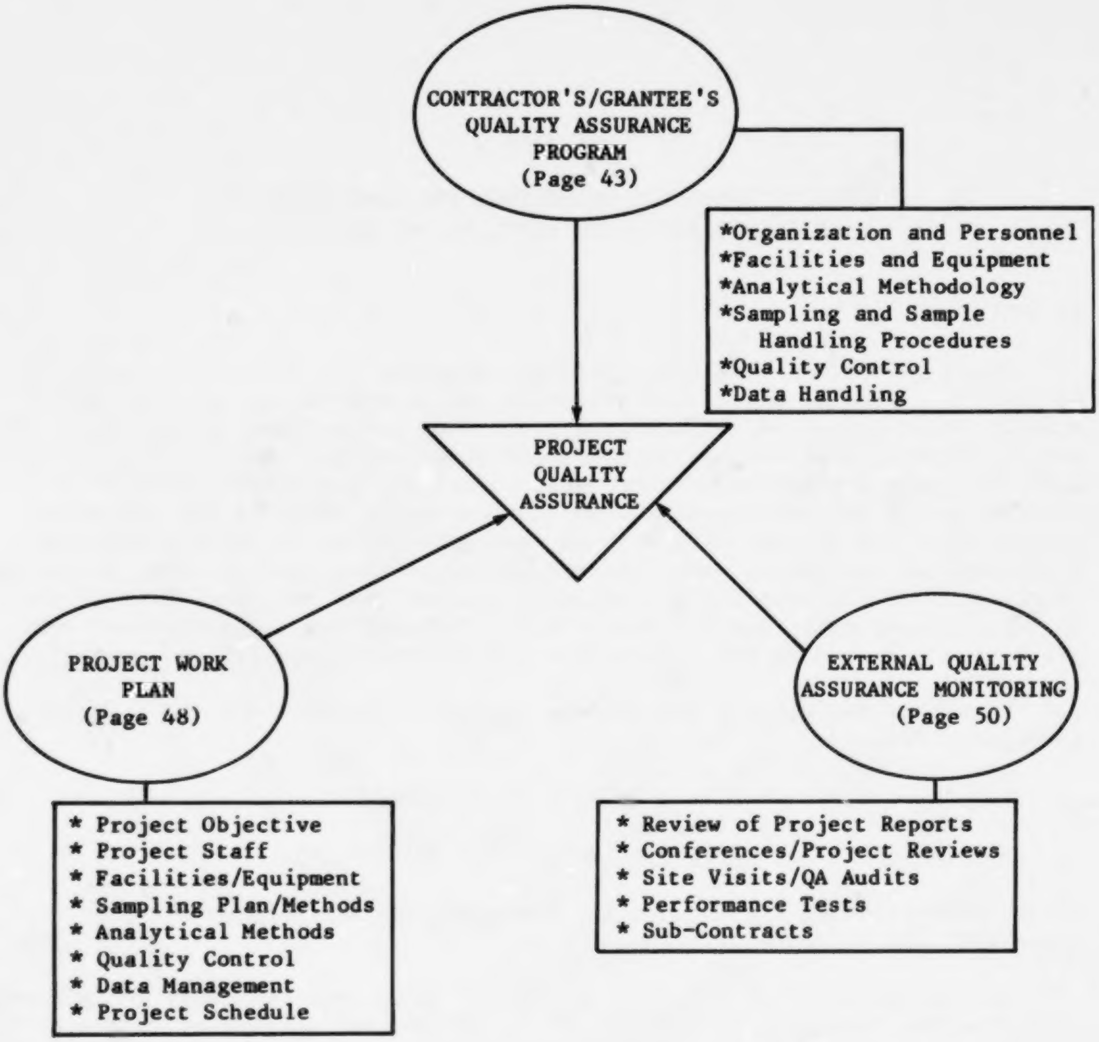
CONTRACTOR'S/GRANTEE'S QUALITY ASSURANCE PROGRAM (Page 43)
*Organization and Personnel
*Facilities and Equipment
*Analytical Methodology
*Sampling and Sample Handling Procedures
*Quality Control
*Data Handling
PROJECT QUALITY ASSURANCE
PROJECT WORK PLAN (Page 48)
* Project Objective
* Project Staff
* Facilities/Equipment
* Sampling Plan/Methods
* Analytical Methods
* Quality Control
* Data Management
* Project Schedule
EXTERNAL QUALITY ASSURANCE MONITORING (Page 50)
* Review of Project Reports
* Conferences/Project Reviews
* Site Visits/QA Audits
* Performance Tests
* Sub-Contracts

Figure 6. Foundations of project quality assurance.

procedures that will be followed to validate the quality of the resulting data. A checklist is provided in Appendix E to assist the Project Officer in reviewing project work plans and to assure that the QA aspects of the plan are given adequate attention.

Project QA monitoring procedures are discussed on page 50. The Project Officer has full responsibility for monitoring of project QA during the course of project accomplishment. Several techniques are described for fulfilling this key project responsibility, including: (1) the effective use of project conferences and project reviews, (2) a number of independent performance tests (e.g., QA audits, performance test samples, split samples), and (3) review of project reports.

PROJECT OFFICER'S QA RESPONSIBILITIES

This section briefly describes the QA-related responsibilities of the Project Officer and discusses how he can influence the quality of the work during the course of the project.

Contracts

Figure 7 is a diagram of the major aspects of contract administration. After award of the contract to the contractor, the Project Officer assumes technical responsibility for project initiation, project monitoring, conclusion, and closeout. The Project Officer fulfills his QA role by interacting with the contractor in each of these five phases of the work.

Project Initiation--

After completion of all negotiations and award of a contract, the Project Officer should discuss with the contractor their respective roles in project quality assurance and the necessity for cooperative efforts to achieve a high-quality result.

The Project Officer should discuss with the contractor how he intends to maintain quality assurance on this project commensurate with the objectives of the effort. He should discuss the three basic foundations of project QA with the contractor. They are: (1) the contractor's QA program, (2) the Project Work Plan, and (3) QA monitoring by the Project Officer or the IERL-Ci Quality Assurance Officer.

At this time, if not provided during procurement, the Project Officer should request a review copy of the contractor's QA program manual. Guidelines for reviewing the contractor's QA program are discussed under "The Contractor's/Grantee's QA Program" (page 43); Appendix D is a checklist to assist the Project Officer in this review. The Project Officer and the contractor should also discuss quality assurance procedures to be addressed in the Project Work Plan, which will be prepared by the contractor before the work begins. The elements of a Project Work Plan are described on page 48. A checklist is also provided in Appendix E to assist the Project Officer in review of the QA aspects of the plan.

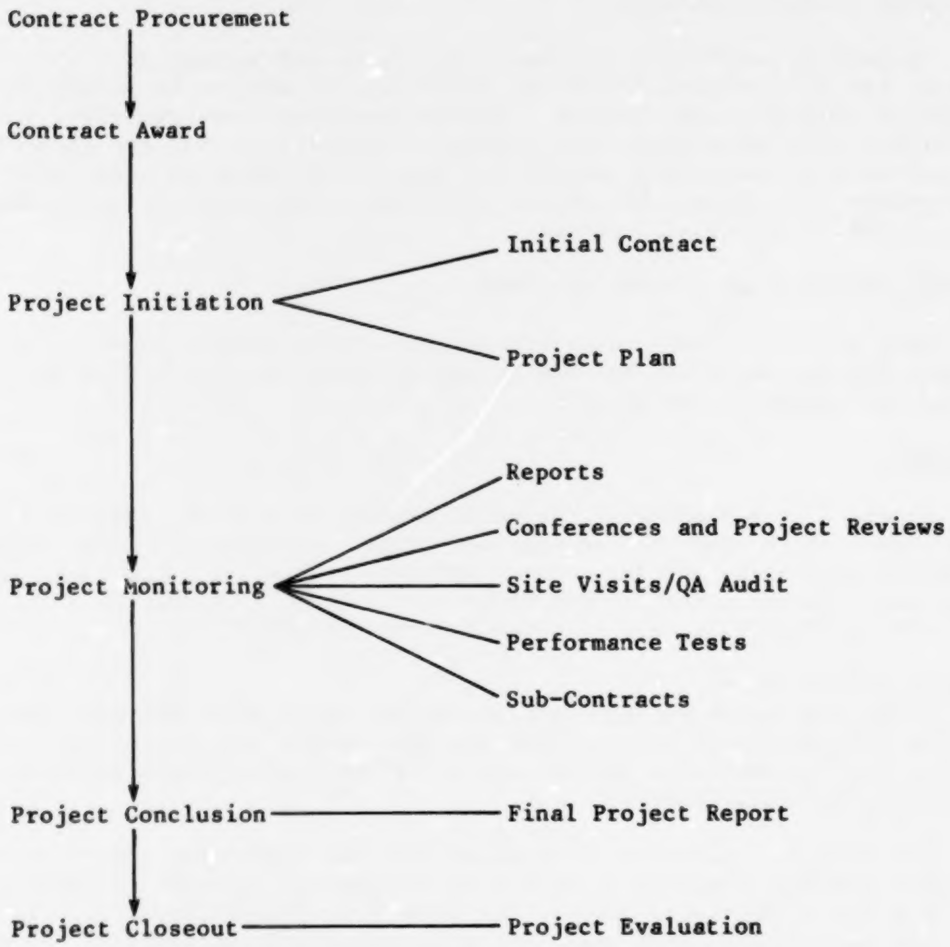
Contract Procurement
Contract Award
Project Initiation
Initial Contact
Project Plan
Project Monitoring
Reports
Conferences and Project Reviews
Site Visits/QA Audit
Performance Tests
Sub-Contracts
Project Conclusion
Final Project Report
Project Closeout
Project Evaluation

Figure 7. Contracts administration.

Project Monitoring--

The Project Officer serves in a key position in QA monitoring of the contractor's project work. There are a number of ways in which he can fulfill this responsibility (Figure 7). He can review all project reports, conduct project conferences and reviews, conduct site visits and QA audits, use performance tests when appropriate, and assure that the same level of QA is applied to all subcontracted work. The IERL-Ci Quality Assurance Officer can assist the Project Officer in accomplishing these responsibilities.

The Project Officer is responsible for the technical content and QA review of all project reports. This includes periodic progress reports, interim reports, task reports, QA reports, and final project reports. Since the Project Officer must approve the Project Work Plan, he should be aware of all sampling, analysis, and QA procedures that are to be employed in development of the data. There remain two areas, then, where the Project Officer should focus his attention in the review of reports: (1) Has all the QA information been documented in the report?, and (2) Are the conclusions which are drawn from the work supported by the sampling and analysis data? Each task report, interim report, and certainly the final report should be reviewed by one or more persons who are technically qualified to assess the quality of the work and the conclusions which are drawn.

In his role as technical representative for EPA, the Project Officer must insure that the contractor is complying with the procedures delineated in his QA program and in the Project Work Plan. One of the most effective ways of doing this is to conduct occasional visits to the study site and to the contractor's laboratories. The contractor should be contacted as early in advance of the visit as practicable and advised of any specific matters to be discussed. The Project Officer must be knowledgeable of the status of the work and of the procedures being used. The visit and observations from the visit should be documented in the project file.

At least one site visit, preferably the first one, should incorporate a QA audit. Procedures and checklists for conducting a QA audit may be found in Section 3 of this document, "Quality Assurance Guidelines for Auditing of Projects Requiring Sampling and Analysis." The Quality Assurance Officer may participate in site visits whenever possible and, in particular, when a QA audit is to be conducted.

The Project Officer may call upon the contractor to conduct one or more performance tests. Performance test samples for many parameters are made available by EPA. Procedures for obtaining these materials are found on page 50. The Project Officer may request the contractor to analyze reference materials in order to establish analytical accuracy and precision of the analytical methods, or he may have split samples analyzed by another laboratory for purposes of comparison. Independent sampling by IERL-Ci or a third party may also be called for if it is important to document certain parameters upon which critical decisions are to be made.

When sampling and/or analytical activities are sub-contracted, it must be made clear that the prime contractor bears full responsibility for the application of QA procedures and for the quality of the final product. The Project Officer should exert the same control as when all work is done only by the prime contractor and no sub-contractor is used. All parties should understand the QA requirements of the program and agree to cooperate in the QA effort. The Project Officer should have direct access to the sub-contractor or, at least, he should feel confident that someone on the prime contractor's project staff is knowledgeable of the technical aspects of the sampling and analysis activities and can represent this area of project activity.

Project Conclusion and Closeout--

Most projects conclude with a final project report. A draft final report is submitted to the Project Officer for review and approval. This is the culmination of the Project Officer's QA responsibilities. He should assure all sampling and analytical data are thoroughly documented and substantiated. Independent review of the final report by other qualified Agency personnel is required.

Each Project Officer is required to complete a Project Officer's Evaluation of Contractor Performance (EPA Form 1900-27) at the conclusion of a contract. The degree to which the contractor has complied with the contracted work scope and the required QA should be reflected in this evaluation so that the Agency may develop an accurate historical performance record of contractors.

Grants and Cooperative Agreements

Unlike contracts management, the Project Officer's role is not one of directing the activities of a grantee. He still has the responsibility, however, of assuring a quality product is delivered to the Agency upon project completion. As shown in Figure 8, he has many of the same responsibilities for project initiation, project monitoring, and project conclusion as he does for a contract (see Figure 2). His basic methods of fulfilling these responsibilities would be the same as described above for contracts, but his approach would be somewhat different, since he is not expected to "direct" the grantee but to "assist" him in achieving the quality requirements of the Agency.

Project Initiation--

Upon grantee acceptance of the grant or cooperative agreement, the Project Officer should inform the grantee that the Agency is concerned that the quality of all sampling and analysis can be documented. He should describe his role in monitoring project QA procedures.

Monitoring of Project QA--

The key responsibility of the Project Officer is the technical monitoring of the grant, basically as a means of assuring that the grantee

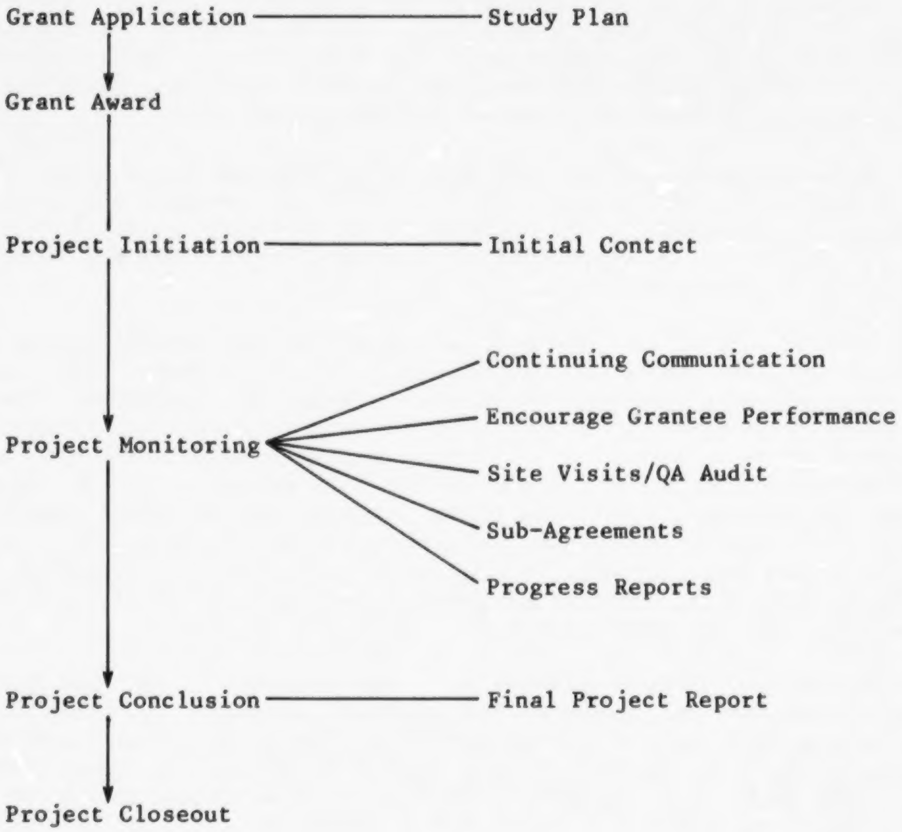
Grant Application
Study Plan
Grant Award
Project Initiation
Initial Contact
Continuing Communication
Encourage Grantee Performance
Project Monitoring
Site Visits/QA Audit
Sub-Agreements
Progress Reports
Project Conclusion
Final Project Report
Project Closeout

Figure 8. Grants and cooperative agreements administration.

carries out the approved scope of work on schedule and in conformance with applicable rules, regulations, and any special conditions that may have been imposed by the grant agreement. The grantee should use currently accepted QA procedures commensurate with the objectives of the effort.

As shown in Figure 8, the study plan is normally approved before project initiation as a result of funding of the grantee's project. Hence, it is critically important that QA be a major consideration in the technical evaluation of grant and cooperative agreement applications. Guidance is provided in the first section of this document, "Quality Assurance Guidelines for Procurement of Projects Requiring Sampling and Analysis."

In carrying out the project monitoring function for a grant or a cooperative agreement, the Project Officer should: (1) conduct site visits and a QA audit as appropriate, (2) monitor the QA practices on any sub-agreements, and (3) review the QA aspects of all progress reports and the final report submitted by the grantee.

The Project Officer may have access to grantee records and to records of contractors under the grant, as well as to the performance site, and should use such access as one tool in monitoring grant QA activities. The frequency of visits is a matter of Project Officer judgment, although it may be affected by the availability of travel funds. As a general rule, a project QA audit should be conducted once during each project. The QA audit is most effectively accomplished early in the project when the first sampling and analysis activities are begun. Recommendations for conducting a QA audit are discussed beginning on page 50. QA audit procedures and checklists may be found in Section 3, "Quality Assurance Guidelines for Auditing of Projects Requiring Sampling and Analysis."

The Project Officer reviews any sub-agreements or sub-contracts under a grant or cooperative agreement for technical content. He should make sure that all sub-agreements are written to include necessary and reasonable QA requirements. The Project Officer should not approve the award of a sub-agreement until he is satisfied that QA requirements equivalent to those expected of the prime grantee have been accepted.

Summary of the Project Officer's Role in Achieving QA

The role of the Project Officer in achieving QA can be best fulfilled by keeping in mind a few working principles.

1. Have a good basic understanding of conventional QA practices and the principles behind project QA. Work with the Quality Assurance Officer whose job it is to be thoroughly knowledgeable of ways to achieve and document good quality work.

2. Be knowledgeable of the sampling and analytical procedures used or ask for assistance from someone who is. Understand the precision

and accuracy which is achievable with the methods and what can most affect the quality of the work.

3. Know the level of QA required to achieve the objectives of the project. Is qualitative or screening information adequate or must the highest possible accuracy be achieved?

4. Be certain the contractor/grantee has adequate funds budgeted to accomplish the work at the level of quality desired without taking unjustified shortcuts to the detriment of QA.

5. Use the IERL-Ci Quality Assurance Officer for independent review of the QA procedures, quality control data, and project reports. Ask him to point out any QA weaknesses in the program.

6. Recognize that the purpose of a QA program is to discover and correct errors. Use well-founded QA practices to identify any sampling or analytical problems before effort is lost in producing unreliable data.

THE CONTRACTOR'S/GRANTEE'S QA PROGRAM

Each contractor or grantee should have a written QA program which describes the in-house procedures that he employs to guarantee, to the extent possible, the quality of all sampling and analysis activities. The contractor's/grantee's QA program is not project specific. It describes the quality assurance and the quality control procedures used on any project which requires sampling and analysis.

There is no standard, universally-accepted QA program. Each contractor and each grantee prepares his own to suit the needs of his organization as he has best determined. There are, however, a number of publications which discuss the recommended contents of a comprehensive QA program. These publications are listed in the Bibliography. Although each author describes the essential elements of a QA program in his own manner and with his own perspective, there is general agreement on what a QA program should contain. These essential elements are described in this chapter. In addition, a checklist has been prepared to aid the Project Officer in reviewing a QA program and to facilitate his feedback to the contractor or grantee on the suitability of his program with respect to IERL-Ci requirements.

Elements of a QA Program

A comprehensive QA program will address the six major elements upon which the final quality of the laboratory's work depends. Generally, these include:

1. Organization and personnel,
2. Facilities and equipment,
3. Analytical methodology,

4. Sampling and sample handling procedures,
5. Quality control, and
6. Data handling.

A comprehensive, well-written QA program will address each of these essential aspects of QA. In the following descriptions these six major areas have been divided into sub-elements, where applicable.

Organization and Personnel--

QA policy and objectives--Each organization should have a written quality assurance policy that should be made known to all organization personnel. Objectives should be established to produce data that meet project requirements in terms of completeness, precision, accuracy, representativeness, documentation, and comparability. The QA program should require the preparation of a project-specific QA plan for each major project.

QA organization--The organization and management of the QA function should be described in the contractor's/grantee's QA document. Reporting relationships and responsibilities should be clearly defined. A QA Coordinator or Supervisor should be appointed and his responsibilities established. A description of the QC paperwork flow should be available. There should be a clear designation of those who are authorized to approve data and results. Responsibilities for taking corrective action should be assigned to appropriate management personnel.

Personnel training--It is highly desirable that there be a programmed training system for employees. This system should include motivation toward producing data of acceptable quality and should involve "practice work" by the new employee. The quality of this work can be immediately verified and discussed by the supervisor, with appropriate corrective action taken.

Document control and revisions--A QA program should include a system for documenting: (1) sampling procedures, (2) calibration procedures, (3) analytical procedures, (4) computational procedures, (5) quality control procedures, (6) field data, and (7) operating procedures, or any changes to these procedures.

Procedures for making revisions to technical documents must be clearly defined, with the lines of authority indicated. Procedural revisions should be written and distributed to all affected individuals, thus insuring implementation of changes.

Documentation control becomes increasingly important in field studies, since procedures must often be adapted to the particular situation, tested, and approved by project management authority. Any revisions to the sampling program must be strictly documented and approved by the Project Officer. Undocumented changes in either the sampling or analysis program can seriously affect the substantiation of the final project conclusions.

Facilities and Equipment--

Procurement and inventory procedures--Purchasing guidelines for all equipment and reagents having an effect on data quality should be well-defined and documented. Similarly, performance specifications should be documented for all items of equipment having an effect on data quality. Once any item which is critical to the sampling and analysis program such as a flowmeter, *in situ* instrument, or reagent is received and accepted by the organization, documentation should be retained of the type, age, and acceptance status of the item. Reagents should be dated upon receipt in order to establish their order of use and to minimize the possibility of exceeding their useful shelf life.

Preventive maintenance--Preventive maintenance procedures should be clearly defined and written for each measurement system and required support equipment. When maintenance activity is necessary, it should be documented on standard forms maintained in logbooks. A history of the maintenance record of each system serves as an indication of the adequacy of maintenance schedules and parts inventory.

Analytical Methodology--

Calibration and operating procedures--Calibration is the process of establishing the relationship of a measurement system output to a known stimulus. In essence, calibration is a reproducible reference point to which all sample measurements can be correlated. A sound calibration program should include provisions for documentation of frequency, conditions, standards, and records reflecting the calibration history of a measurement system.

The accuracy of the calibration standards is an important point to consider since all data will be in reference to the standards used. A program for verifying the accuracy of all working standards against primary grade standards should be routinely followed.

Feedback and corrective action--The QA program should specify the corrective action that is to be taken when an analytical or sampling error is discovered. The program should require documentation of the corrective action and notification of the analyst or sample collector of the error and correct procedures.

Sampling and Sample Handling Procedures--

Configuration control--Some sampling and analysis programs require a more or less elaborate array of sampling equipment, sampling systems, or *in situ* instrumentation. It is important for quality assurance that once such an array has been established, the configuration of the array should be documented. Furthermore, any changes in the configuration must be made only after due consideration of the effects on the data which are gathered. Any changes in configuration or design changes in the sampling or analysis system must be thoroughly documented.

Reliability--The reliability of each component of a measurement system is related directly to the probability of obtaining valid data from that system. It follows that procedures for reliably collecting, processing, and reporting data should be clearly defined and in written form for each system component. Reliability data should be recorded on standard forms and kept in a logbook for easy reference. If this procedure is followed, the data can be used in revising maintenance and/or replacement schedules.

Quality Control--

Quality control procedures--The quality control procedures used during sampling and analysis should be described. The quality control checks routinely performed during sample analysis include reagent blank analysis to establish background absorbance, duplicate analysis to establish analytical precision, and spiked and blank sample analysis to determine analytical accuracy. The frequency of these quality assurance checks should be specified. Limits of acceptance or rejection should be defined for analysis and control charts should be used where practicable. Gas chromatography confirmation procedures should be discussed.

Control checks and internal audits--A good QA program will make provision for periodic control checks and internal audits by the performing organization. Several approaches are commonly used for control checks. These include:

1. Reference material analysis. Analytical reference materials are available from several commercial and government sources, or they may be prepared in-house. The National Bureau of Standards (NBS) has made available a series of standard reference materials which may be purchased. The chemical analysis of these materials has been well established. Such materials can be analyzed alongside routine samples and the results used to check the accuracy of analytical procedures.

2. Split sample analysis. The analysis by two or more analysts of a single sample that has been well mixed and divided is useful for establishing precision of the analytical techniques and the performance of the analysts.

3. Spiked sample analysis. The analysis of a routine sample which has been spiked with a known amount of the measured material should be commonly employed to establish the recovery of an analytical method.

4. Side-by-side analysis. Under particularly intractable conditions where it is important to acquire useful data but difficult to control all important variables, it may be useful to conduct

side-by-side analysis by two analysts. These analysts may use the same or perhaps different analytical methods to acquire comparable data.

5. Reference devices. Some measurement systems, in particular flow measurement systems, can be checked by the use of available reference devices. The use of these devices are generally disruptive to the operation and can seldom be employed without the knowledge of the operator or the analyst.

Internal audits should be periodically conducted to evaluate the functioning of the QA program. This involves an independent check of the performance of the field crew or the laboratory analysts to determine if prescribed procedures are closely followed.

Data Handling--

Data handling, reporting, and recordkeeping--Data handling, reporting, and recordkeeping procedures should be described. Data handling and reporting includes all procedures used to record data on standard forms, laboratory or field notebooks. This includes bench data and field data. The reporting format for different types of bench data should be discussed and the forms provided. The contents of field notebooks should be specified.

Recordkeeping of this type serves at least two useful functions: (1) it makes possible the reanalysis of a set of data at a future time, and (2) it may be used in support of the experimental conclusions if various aspects of the study are called into question.

Data validation--Data validation procedures, defined ideally as a set of computerized and manual checks applied at various appropriate levels of the measurement process, should be in written form and clearly defined for all measurement systems. Criteria for data validation must be documented and include limits on: (1) operational parameters such as flow rates; (2) calibration data; (3) special checks unique to each measurement, e.g., successive values/averages; (4) statistical tests, e.g., outliers; and (5) manual checks such as hand calculations. The limits must be adequate to insure a high probability of detecting invalid data for either all or the majority of the measurement systems. The required data validation activities (flow rate checks, analytical precision, etc.) must be recorded on standard forms in a logbook.

QA Program Checklist

An important responsibility of the Project Officer, as described on page 37 for contracts and page 40 for grants and cooperative agreements, is to review the QA program of the contractor or grantee before project work begins. A checklist has been provided in Appendix D to assist the Project Officer in reviewing a contractor's or grantee's QA program. In the event a contractor/grantee does not have a written QA program, this checklist may still be used to evaluate the QA procedures employed or to assist the contractor/grantee to develop a suitable QA program.

This checklist applies to a "model" QA program; hence, many programs will have deficiencies. It is up to the judgment of the Project Officer, after the review of the QA program and possibly clarifying discussions with the contractor/grantee, whether to accept the program or require upgrading of the program before project work begins. The Quality Assurance Officer can help the Project Officer in applying standards that conform with those used on other IERL-Ci projects of a similar nature.

THE PROJECT WORK PLAN

A work plan should be prepared before commencement of each project. The work plan normally consists of:

1. A statement of project objectives,
2. Description of the project staff,
3. Facilities and equipment,
4. A sampling plan,
5. An analytical plan,
6. The Project QA Plan, and
7. The project schedule.

It is Agency policy that all extramural projects involving environmental measurements must have a Project QA Plan (Costle, 1979). Although the Project QA Plan, which is generally a section of the Project Work Plan, specifically addresses quality assurance of the sampling and analysis effort, in the broader sense the total work plan encompasses aspects of project quality assurance. For contracts, the QA Plan is an integral part of the Project Work Plan, which is prepared after award of the contract (see Figure 2) and submitted to the Project Officer for review and approval before sampling and analysis begins. For research and demonstration grants or cooperative agreements, the QA Plan should be a key section of the Study Plan which accompanies the grantee's formal application. If this is not the case, the Project Officer should request that the grantee prepare a QA Plan for the project and submit it for review in the initial stage of the effort.

Elements of a Project QA Plan

Project Objective--

The objective of the project and of the sampling and analysis effort should be stated in clear and concise terms. From the statement of the objective, one should derive the level of QA to be applied to sampling and analysis activities and this, also, should be clearly stated.

The Project Officer should review the recommendations of the contractor or grantee and assure that he is in agreement with the stated use of the data and the appropriateness of the level of QA to be applied to the data collection activities.

Project Staff--

Project reporting relationships should be shown. Normally on projects requiring sampling and analysis, a Quality Assurance Supervisor should be assigned. His responsibility should be to monitor the quality (internal audit) of the sampling and analysis program and to assure that stated procedures are, in fact, being employed. He should initiate corrective action when problems are detected.

Facilities and Equipment--

The facilities, instrumentation, and equipment that are unique or critical to the success of the effort should be described. This would include: (1) on-site and *in situ* instrumentation, (2) sampling equipment, (3) mobile facilities, (4) temporary facilities, (5) subcontractor- or vendor-supplied equipment, (6) government equipment or facilities, and (7) special safety equipment. Operation and maintenance procedures should be described.

Sampling Plan and Methods--

The sampling plan should be discussed in the detail necessary. Sample points should be precisely located on a site or system diagram and the methods of collecting the sample(s) should be described. The sampling schedule should be established, as should the procedures to guarantee representative samples. The containers and preservatives that are to be used should be described as well as methods to avoid sample contamination. The sampling plan should describe how maximum sample holding time limitations can be met and how samples will be transported to the laboratory.

Analytical Methods--

Standard analytical methods should be employed when applicable. When standard methods are not available, the methods employed should be documented in step-by-step detail. For example, method validation would be required for adoption of a standard method to a sample matrix other than that for which it was designed, or development of a non-standard method. Analytical detection limits and an assessment of the anticipated variance, precision, and accuracy should be stated.

Project QA Plan--

The Project QA Plan should describe the application of the grantee's general QA program to the project. It should be project-specific and should describe what steps are to be taken to assure that the resultant sampling and analytical data are reliable and suitable to project needs. The Project QA Plan should specify such items as:

1. The steps taken to avoid sample contamination,
2. The method chosen to assure each sample is representative of the source,
3. The collection of background or baseline samples,
4. The frequency of duplicate sample collection,
5. The use of blank samples and field spiked samples,
6. Split sample analysis,

7. The method of establishing data precision, and
8. The method of establishing data accuracy.

Project Schedule--

All project plans require a schedule of accomplishment and milestones. The schedule should allow adequate time for the sampling and analysis program, for QA review of the results, and for corrective actions.

Project Work Plan Checklist

Appendix E is a checklist which has been developed to assist the Project Officer in reviewing the Project Work Plan submitted by the contractor or grantee. This checklist is intended to represent the degree of detail that may be expected of a "model" Project Work Plan. The results of the checklist responses should help the Project Officer to specify improvements that are necessary or to have confidence that the project plan adequately addresses QA for the purposes of the effort. Before use of this checklist, the Project Officer should have a clear understanding of the level of QA required to meet project requirements. The IERL-Ci Quality Assurance Officer can assist the Project Officer in this review, and he can help the Project Officer apply standards that conform with those used on other IERL-Ci projects of a similar nature.

PROJECT QA MONITORING

The third foundation of project quality assurance is external QA monitoring. To be thoroughly effective, a QA program and a Project QA Plan should be tested from time to time. This is a responsibility of the Project Officer. He is encouraged, however, to request the assistance of the IERL-Ci Quality Assurance Officer.

External QA monitoring may be accomplished by use of some of the same techniques used for internal audits (page 43), namely: (1) reference materials analysis, (2) split sample analysis, (3) spiked sample analysis, (4) side-by-side sample analysis, and (5) reference devices. In addition to these, the Project Officer may make use of available performance test samples, or he may conduct a QA audit of the project.

The IERL-Ci Quality Assurance Officer is prepared to assist the Project Officer in using any of these methods to monitor the quality of the sampling and analysis aspects of the project. At the request of the Project Officer, he will arrange for reference or performance test samples to be sent to the contractor/grantee, he will arrange for a project QA audit, or he will arrange for split or side-by-side sample analysis.

Methods of Monitoring Contractor/Grantee QA

The QA performance of a contractor or grantee can be monitored from time to time throughout the project by:

1. Review of project reports,
2. Conference and project reviews,
3. Site visits,
4. Performance tests, and
5. Monitoring any sub-contracts.

The Project Officer should apply these methods throughout the course of a project.

Review of Project Reports--

The Project Officer has the responsibility of reviewing all technical project reports submitted by the contractor or grantee. This would include progress reports, interim reports, task reports, QA reports, and final project reports. In reviewing project technical reports, the Project Officer should expect to see a summary of the quality control data in accordance with the approved Project QA Plan. Any conclusions resulting from the project should be supported by the sampling and analysis results when one takes the quality control data into consideration. For example, the author should not attempt to interpret different values for a given parameter measured at two points in a system when the difference between the values is not greater than the parameter variance with a high level of confidence.

The analytical methods should be discussed in the final project report. If standard methods have been used, references should be provided to their source. Non-standard methods should be described in step-by-step detail.

The data should be tabulated or displayed in a logical and understandable manner with the appropriate number of significant figures and appropriate units. Detection limits should be indicated for parameters where values are below the detection limit. Mean values should be reported, but supported by the range and standard deviation determined by replicate analysis.

The final report should describe the sampling program and methods. Sampling points should be shown on an appropriate schematic diagram. Any specialized sampling techniques should be discussed in detail while standard methods should be properly referenced.

Conferences and Project Reviews--

Whenever a conference or project review meeting is held, the Project Officer should make a special effort to review project QA. He should review field notebooks or laboratory notebooks for completeness. A summary should be provided of the quality control data and the results reviewed. Are accuracy and precision adequate to accomplish the objectives of the program or must changes be made in either sampling or analytical techniques? Are sample points properly located to collect representative samples? Are short holding time parameters being analyzed quickly enough after sample collection? Is the Project QA Plan being followed or have undocumented changes been made? Questions of this type should be asked by the Project Officer in order to test the efficacy of both the contractor's/grantee's QA program and the Project QA Plan.

Site Visits and QA Audits--

Site visits to the facilities of the contractor or grantee and to the sampling or demonstration site can be conducted as often as practicable and necessary to keep abreast of technical progress. Such visits can serve as a major QA function. At least one site visit during the course of the technical work on a project should incorporate a QA audit.

QA audit procedures and checklists are provided in Section 3, "Quality Assurance Guidelines for Auditing of Projects Requiring Sampling and Analysis." The Project Officer is referred to this document for further information on this very important tool for project QA monitoring.

Performance Tests--

Performance tests may consist of: (1) analysis of performance test samples provided by the Agency, (2) analysis of split samples by another laboratory, (3) independent sampling and analysis by another laboratory, or (4) reference sample analysis.

Performance test samples are prepared samples of known concentration. They have been prepared and are made available to Project Officers by the EPA Environmental Monitoring Systems Laboratories (Cincinnati, Las Vegas, and Research Triangle Park) through the IERL-Ci Quality Assurance Officer. Reference standards can also be obtained from the National Bureau of Standards (NBS) through the IERL-Ci Quality Assurance Officer.

If it has been decided to use performance test samples, inform the IERL-Ci Quality Assurance Officer of your needs for test samples, and he will arrange to have them sent to the contractor or grantee.

If the Project Officer wishes to have one or more samples split and analyzed by another laboratory, he should contact the IERL-Ci Quality Assurance Officer who can make arrangements for the independent analysis. In a similar manner, he may arrange for independent sampling and analysis if this is considered necessary by the Project Officer as a QA check on the work of the contractor/grantee.

Sub-Contracts and Sub-Agreements--

In the event sub-contracted services are used for either sampling or analysis, the Project Officer should review the sub-contractor's QA program using the checklist in Appendix D. It should meet the same requirements that would be expected of the prime contractor/grantee if he were doing the work in-house. The prime contractor/grantee has full responsibility for the quality of the work just as if it were conducted within his own organization. When a substantial amount of the effort or a particularly critical part of the sampling or analysis is to be accomplished by a sub-contractor or by a sub-agreement, a QA audit should be conducted.

SECTION 3

QUALITY ASSURANCE GUIDELINES FOR AUDITING OF PROJECTS REQUIRING SAMPLING AND ANALYSIS

INTRODUCTION

Quality Assurance Audits

This section provides guidelines for the evaluation of the performance of a contractor, grantee, or agency sampling and analysis program and describes the QA audit process. Specific guidelines are provided to:

1. Determine when to conduct a QA audit,
2. Assist Project Officers in conducting QA audits of grants and contracts requiring sampling and analysis,
3. Assist those who conduct the QA audit in evaluation of the results, and
4. Outline the procedures for the reporting of information to the contractor, grantee, or agency doing the work thereby allowing them to correct any significant QA deficiencies.

In addition, the Quality Assurance Officer is available to conduct or to assist in conducting quality assurance audits. A checklist is provided to facilitate the QA auditing process.

Quality Assurance in Audits

In the procurement phase of contracting, the EPA Project Officer uses quality assurance criteria to aid in the selection of the most qualified contractor. Selection of a contractor or specifying QA criteria for in-house projects and grants, however, does not guarantee that the overall performance on the project will meet the QA requirements. Therefore, it is necessary at times to perform laboratory quality assurance audits. These audits help to assure the Project Officer that all the necessary quality assurance is being applied by the project team in order to deliver a quality product. Quality assurance audits allow the Project Officer to determine that:

1. The Organization and Personnel are qualified to perform assigned tasks;
2. Adequate Facilities are available;
3. Proper Analytical Methodology is being used;
4. Proper Sample and Sample Handling Procedures, including chain-of-custody of samples, are being used;

5. Adequate analytical Quality Control, including reference samples, control charts, and documented corrective action measures, is being provided; and
6. Acceptable Data Handling and documentation techniques are being used.

QUALITY ASSURANCE AUDIT GUIDELINES

When to Conduct a Quality Assurance Audit

A QA audit should be conducted on all projects requiring sampling and analysis services, especially those which provide data that are:

1. Used to make economically important decisions,
2. Used for regulatory monitoring,
3. Used for regulation promulgation, or
4. Used for enforcement activities.

A QA audit of an on-going project can assure the Project Officer that adequate QA measures are being taken to yield data of acceptable quality. It will also convey to the laboratory organization audited that the Project Officer places a high degree of importance on the quality of sampling and analytical effort. A QA audit should not be used as a punitive device to express displeasure with the performance of an organization, but should be used to jointly establish acceptable QA procedures for the given project. The Project Officer is dependent on reliable sampling and analytical data to accomplish the objectives of the project. The contractor, grantee, or government organization conducting the sampling and analysis is also interested in providing reliable data. It should be remembered that both have the same objectives. Hence, cooperative efforts toward this end are likely to be highly successful.

Ideally, a QA audit should be conducted early in a project, preferably before the first sampling and analysis effort is completed. This is the best time to influence the outcome of the entire project. If a project plan calls for periodic sampling and analysis, it is recommended that the QA audit be scheduled during the first or second phase of the sampling and analytical effort. For example, if a project is of 12-month duration and requires monthly sampling, the QA audit should be conducted during the first or second month of the project. Of course, QA audits may be conducted more than once during a project or may be repeated when necessary to affirm that acceptable QA procedures are in use.

Audit Worksheet and Checklist

There are a large number of quality control procedures which can be observed during the course of a laboratory audit. Since an audit rarely lasts longer than one day and can often be as short as a few hours, an auditing procedure must be used which can provide the Project Officer or his designee with the greatest amount of relevant information in the shortest amount of time.

The approach taken by these guidelines is to combine all applicable aspects of a laboratory quality assurance program into the general categories listed below.

1. Organization and Personnel
2. Facilities
3. Sampling and Sample Handling Procedures
4. Analytical Methodology
5. Quality Control
6. Data Handling

Two forms incorporating the preceding information have been prepared to assist the Project Officer in performing a laboratory audit. The first form is a worksheet which is sent to the laboratory scheduled to be audited. This form should be mailed to the project manager of the laboratory approximately one month before the anticipated audit.

The laboratory should complete the worksheet and return it to the EPA Project Officer within two weeks of the anticipated audit. The Project Officer will then screen the worksheet for areas which may require more detailed explanations. This screening process should be limited to those areas of importance in the sampling and analysis efforts of the project.

Some information which is requested in the worksheet may be available in the original proposal or grant application. The use of this information in completing the worksheet is encouraged to minimize the QA audit cost.

The second form which has been developed is a checklist for use by the Project Officer or his representative in performing the audit. The checklist has been developed to:

1. Verify a representative number of responses received in the worksheet,
2. Elicit more project-specific information, and
3. Provide the Project Officer additional information to use in evaluating the laboratory.

The worksheet and checklist have been developed for performing QA audits on projects with either: (1) a scope of work encompassing several scientific areas, or (2) projects with a limited scope of work which do not have specific audit procedures available. Specific QA elements for all IERL-Ci projects are addressed in Section 2. Available auditing procedures are listed in Table 8. Since auditing procedures are project-specific and can be used to perform an audit in much greater detail, they should be employed where available. The laboratory worksheet and the checklist are appended.

TABLE 8. AVAILABLE QUALITY ASSURANCE AUDIT PROCEDURES

Parameter	Reference
Ambient Sulfur Dioxide (Pararosaniline) Lab and Field	U.S. Environmental Protection Agency. 1976. Criteria and Procedures for the Evaluation of Ambient Air Monitoring Programs --Laboratory and Field.
Ambient Nitrogen Dioxide (Sodium Arsenite) Lab and Field	(same as above)
Total Suspended Particulate (Hi-Volume Method)	(same as above)
Photochemical Oxidants (Chemiluminescent)	(same as above)
Carbon Dioxide (Non-Dispersive Infrared)	(same as above)
Metals, Organics, and Inorganics in Drinking Water	U.S. Environmental Protection Agency. 1977. Manual for the Interim Certification of Laboratories Involved in Analyzing Public Drinking Water Supplies. Washington, D.C. EPA-600/8-78-008. U.S. Environmental Protection Agency. 1979. Handbook for Analytical Quality Control. Cincinnati, Ohio.
Radiation in Drinking Water	(same as above)
Bacteria in Drinking Water	U.S. Environmental Protection Agency. National Environmental Research Laboratory. 1975. Handbook for Evaluating Water Bacteriological Laboratories. Cincinnati, Ohio. EPA-670/9-75-006.

(continued)

TABLE 8 (continued)

Parameter	Reference
Bacteria in Drinking Water (Cont.)	U.S. Environmental Protection Agency. Environmental Monitoring and Support Laboratory. 1978. Microbiological Methods for Monitoring the Environment, Cincinnati, Ohio. EPA-600/8-78-017.
Biological Sampling	U.S. Environmental Protection Agency. Environmental Monitoring and Support Laboratory. 1978. Quality Assurance Guidelines for Biological Testing. Las Vegas, Nevada. EPA-600/4-78-043.

Use of Performance Test Samples

Performance test samples, when available, present the Project Officer with an alternate method of performing a laboratory audit on a project which requires sampling and analysis. EPA has prepared and has available test samples for numerous parameters in many different matrices.

Certain projects will not warrant a full-scale, on-site audit even though the data produced by the sampling and analysis effort meets the criteria established (see page 54). Table 5, page 22, establishes the criteria to be used in determining the necessity of requiring performance test samples. In these cases, test samples can be used to audit the analytical performance of the laboratory.

Other projects may be of sufficient importance to require both an on-site audit and performance test samples. When problems in analytical procedures are identified during an on-site audit, performance test samples can be used to verify that discrepancies have been corrected by the laboratory.

Performance test samples should not be used indiscriminately. They are generally expensive for EPA and the laboratory to prepare, analyze, and evaluate. The supply of test samples is not unlimited; however, in cases where their value can be established, they should be used. Performance test samples for audit purposes can be obtained through the Quality Assurance Officer (QAO), IERL-Ci. The QAO can also provide guidelines in the interpretation of the results. A listing of currently available performance test samples is found in Appendix B.

After performance test samples are analyzed and the results evaluated, the performing laboratory should be notified of the true value of the samples and the range of acceptance. In cases where limited sets of samples are yet unknown by laboratories, it may not be possible to provide the absolute true values. When it is inadvisable to inform the laboratory of the true value, the EMSL through the IERL-Ci Quality Assurance Officer should provide information, in writing, as to the acceptability/unacceptability and whether the results tended to be high or low.

CONDUCTING THE QUALITY ASSURANCE AUDIT

Review of Worksheet

This section describes the three basic steps for performing a QA audit. These steps are: (1) evaluating the returned worksheet to determine areas to be examined during the site visit, (2) conducting the site visit, and (3) evaluating the QA audit results, including preparation of an audit report. This section describes how to evaluate the worksheet returned by the organization to be audited. This worksheet is in Appendix F.

Organization and Personnel--

This section of the worksheet is designed to: (1) familiarize the person performing the audit with the laboratory's organizational structure, (2) identify the key personnel involved in the project, and (3) acquaint the QA auditor with the skills and training of personnel actually involved in the sampling and analysis effort. The QA auditor should familiarize himself with the Project Manager, the person responsible for field sampling (if required on this project), and the person responsible for the overall analytical program.

Appendix G has been prepared to aid the QA auditor in evaluating the skills and training of the personnel responsible for sample collection and analyses. Individuals with assigned responsibilities, as indicated in the worksheet, should be compared with the qualifications noted Appendix G to ascertain that the laboratory is placing proper emphasis on quality assurance. Any areas which may appear weak should be noted for discussion during performance of the QA audit.

Facilities and Equipment--

The instrumentation necessary for the successful performance of a laboratory on a given project is highly dependent on the nature of the project. The laboratory has been selected based on skills in the project field and, therefore, will provide a comprehensive list of the necessary instrumentation. The QA auditor should review the list of major instrumentation in order to: (1) determine the type of instrumentation he will encounter during his site visit, (2) note any instrumentation which may have been overlooked in the preparation of the worksheet, and (3) acquaint himself with any unfamiliar instrumentation in order to perform a proper evaluation during the QA audit. A listing of instrumentation and equipment needed for various sampling and analysis functions is listed in Appendix G.

Other equipment and facilities, such as analytical balances, lighting, etc., which were not covered by the worksheet will be evaluated on the checklist during the QA audit. As a general rule, laboratory space for analytical requirements should include approximately 120 square feet of working space and 6 linear feet of unencumbered bench space for each analyst.

Analytical Methodology--

Methods of analysis vary according to the sample matrix (e.g., air, soil, sediment, wastewater, drinking water, seawater, etc.). A list of accepted methods for various media and scientific fields is presented in Appendix C. These accepted methods should be compared with the analytical methodologies listed in the completed worksheet. Any differences between these methods and the methods listed by the contractor/grantee should be noted and discussed during the on-site QA audit.

Sampling and Sample Handling Procedures--

If sample collection constitutes a major portion of the work effort, the QA auditor should consider it as part of the QA audit program and should study the sampling plan, sample handling, and chain-of-custody procedures proposed by the laboratory. The QA auditor should make every attempt to meet with laboratory personnel at the sampling location and to observe the quality control procedures practiced during sampling. Appendix H has been compiled to aid the auditor in determining correct sample preservation methods.

Quality Control--

The worksheet poses many basic quality control questions. These questions should be screened by the QA auditor to note: (1) any questions answered no; and (2) if QA manuals, standard operating procedures, etc., are available for inspection during the on-site survey. Each of the questions answered yes is a potential area where the depth of the QA applied by the laboratory can be probed to determine the degree of commitment to quality assurance on the project.

Data Handling--

This area covered by the worksheet allows the QA auditor to determine the availability of such items as field sampling notebooks and past data. It also gives some idea as to the degree of quality assurance practiced by the laboratory in: (1) analyzing samples within recommended holding times, (2) rechecking of calculations, (3) rejecting data, and (4) cross-checking data to reduce the possibility of confusing data and sample numbers.

Site Visit

QA audits should be planned to minimize the amount of time on site and to maximize the amount of information which can be obtained. Implementation of these guidelines should assure that the QA auditor's portion of the on-site inspection can be completed in a maximum of six hours. In meeting this goal, the following procedures should be used:

1. Contact the Project Manager and arrange a mutually agreeable time and date for the site visit. If field sampling will be included in the audit, the necessary arrangements should be made at this time.

2. Study the worksheet completed by the laboratory and identify the key personnel. Note any questions unresolved by the pre-audit worksheet on the QA audit form. Ask that the key project personnel be available for discussions.

3. Prepare an agenda for the meeting which includes: (a) meeting with key personnel in the laboratory organization, (b) a brief discussion of the purpose of the QA audit, (c) a tour of the facilities, and (d) discussions with all personnel who can assist in completing the QA checklist form (Appendix I). Table 9 is a proposed agenda.

4. If a field audit is to be performed, an agenda should be arranged with the laboratory to minimize any interference that the audit might have on the field sampling effort.

TABLE 9. RECOMMENDED AGENDA FOR QA AUDIT SITE VISIT*

A. Meet with Key Project Personnel

  1. Introductions
  2. Describe purpose of visit

B. Description of the Sampling and Analytical Effort

  1. Sampling
  2. Analysis
  3. Data presentation and interpretation

C. Quality Assurance Program

  1. Description
  2. Discussions with key project personnel
  3. Discussion of worksheet review

D. Tour of Facilities

  1. Checklist
  2. Discussions with staff personnel

E. Debriefing

  1. Preliminary evaluation
  2. Serious problems requiring immediate corrective action
  3. Schedule for QA audit

*A minimum of one hour should be devoted to each section of B through E.

Quality Assurance Audit Report

A written report of the QA audit results must be prepared. This report should include:

1. An assessment of the performing organization's status in each of the major areas addressed, including personnel, facilities, procedures, and quality control.
2. A clear statement of areas requiring improvement or problems to be corrected.
3. A timetable for correction of problem areas.

To effectively achieve QA audit objectives, the report should be sent to the performing organization as soon as possible, preferably within 15 working days of completion of the audit evaluation. Corrective action, when required, should be scheduled to meet the timetable of the project.

Figure 9 is a suggested format for the QA audit report. Both the Pre-Audit Worksheet and the Audit Checklist should be appended to this report.

The original QA Audit Report is maintained by the IERL-Ci Quality Assurance Officer, and copies should be distributed as follows:

Copies	
1	Project Officer
1	Extramural Laboratory Project Manager

If the QA audit was satisfactory and no specific followup action is required, the QA audit is complete. If deficiencies have been noted and corrective actions specified, then the Project Officer must assure that corrections have been made in accordance with the specified timetable. Written communications should be entered into the project file to document the correction of noted deficiencies. The principal investigator should be invited to submit any response he desires for inclusion into the project file.

QUALITY ASSURANCE AUDIT REPORT

Project:____

Contract/Grant No.:____________ Project Officer:__________________

Laboratory Audited:____

City:______________________ State:____________________

Laboratory Director:__________________________________

Audit Conducted By:__________________________________

Agency:______________________________________

Date:_______________________________________

PURPOSE AND OBJECTIVES OF THE PROJECT:

BRIEF DESCRIPTION OF THE SAMPLING AND ANALYTICAL REQUIREMENTS:

Figure 9. Quality Assurance Audit Report.

RESULTS OF THE QUALITY ASSURANCE AUDIT
Organization and Personnel
Facilities
Analytical Methodology

Figure 9 (continued)

RESULTS OF THE QUALITY ASSURANCE AUDIT
Sampling and Sample Handling
Quality Control
Data Handling

Figure 9 (continued)

QUALITY ASSURANCE DEFICIENCIES:
RECOMMENDED CORRECTIVE ACTIONS AND TIMETABLE:

Signed Date

Title

Distribution:

Project Officer
Quality Assurance Officer
Contractor/Grantee

Figure 9 (continued)

SECTION 4

CONCLUSIONS

PROCUREMENT

Section 1 of this document provides suggestions, recommendations, and procedures whereby Project Officers can introduce QA considerations into the procurement process when sampling and analysis is involved in the work. Specific recommendations are given for determining the appropriate weighting to apply to QA in the proposal evaluation criteria for contracts. Contractors and grantees must comply with IERL-Ci quality assurance requirements, if the Laboratory is to achieve its assigned mission of developing new and improved pollution control technology. These quality assurance program requirements are intended to be stringent but justifiable. Conscientious application by IERL-Ci Project Officers of the procedures described in Section 1 should result in equitable treatment of all offerors and grant applicants.

MONITORING

Section 2 of this document has been prepared by the IERL-Ci Quality Assurance officer to describe procedures to maintain the quality of sampling and analysis activities conducted by contractors and grantees under the direction or funding of IERL-Ci. Of paramount importance in achieving and maintaining quality work is the role and responsibilities of the Project Officer. These responsibilities have been defined and discussed for contracts, grants, and cooperative agreements.

The three foundations of project QA: (1) the contractor's/grantee's QA program, (2) the Project Work Plan, and (3) project QA monitoring have been discussed from the standpoint of the review responsibilities of the Project Officer. Checklists are provided to assist the Project Officer in reviewing contractor/grantee QA programs and project work plans.

If the Laboratory is to achieve its assigned mission of developing new and improved pollution control technology in a cost-effective manner, then each project must incorporate sound QA practices. Contractors and grantees must be informed of and comply with IERL-Ci quality assurance requirements.

AUDITING

Procedures and a checklist are provided in Section 3 for conducting quality assurance audits of on-going IERL-Ci projects which require sampling and analysis services. It is recommended that a QA audit be conducted during the beginning stages of all projects which require significant amounts of sampling and analysis.

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APPENDIX A

QUALITY ASSURANCE EVALUATION CRITERIA CHECKLIST FOR PROPOSALS AND GRANT APPLICATIONS OFFERING SAMPLING AND ANALYSIS SERVICES

Criteria	Scoring Value	x	Numerical Weight	=	Individual Score
A. Quality assurance management policy/written procedures.					
1a. Does the offeror have an on-going QA program?	_____	x	5	=	_____
2a. Does the offeror have a written QA manual that he will make available for review?	_____	x	4	=	_____
3a. Has the offeror designated a QA coordinator or a QA supervisor who reports to senior management levels?	_____	x	3	=	_____
4a. Does the proposed project management structure provide for adequate QA?	_____	x	2	=	_____
5a. Will a project specific QC plan be prepared before commencement of sampling and analysis?	_____	x	1	=	_____
	Total Score for Sub-element A.				_____
	Maximum Possible Score				75

Percent of maximum possible score awarded for Sub-element A. (circle closest value).

0%   20%   40%   --   60%   80%   100%

Score for this sub-element of the proposal evaluation criteria (circle corresponding value).

0   1   2a   2b   3   4   5

Criteria	Scoring Value	x	Numerical Weight	=	Individual Score
B. Quality assurance procedures for sampling.					
1b. Are sampling locations chosen to assure representative samples will be taken?	_____	x	2	=	_____
2b. Will the proposed sampling program yield data of statistical significance as appropriate to the objectives of the project (e.g., replicate samples, background samples, etc., should be discussed)?	_____	x	2	=	_____
3b. Does the offeror show an understanding of the proper techniques used to collect representative samples while avoiding sample contamination?	_____	x	3	=	_____
4b. Does the offeror have access to the appropriate sampling equipment?	_____	x	2	=	_____
5b. Are samples to be shipped promptly to the laboratory to meet maximum sample holding time limitations?	_____	x	3	=	_____
6b. Are appropriate sample preservation methods proposed?	_____	x	2	=	_____
7b. Are sample chain-of-custody procedures described?	_____	x	1	=	_____
Total Score for Sub-element B.					_____
Maximum Possible Score					75

Percent of maximum possible score awarded for Sub-element B. (circle closest value).

0%　20%　40%　--　60%　80%　100%

Score for this sub-element of the proposal evaluation criteria (circle corresponding value).

0　1　2a　2b　3　4　5

APPENDIX A (continued)

Criteria	Scoring Value	x	Numerical Weight	=	Individual Score
C. Quality assurance procedures for analysis.					
1c. Does the offeror intend to use standard analytical methods* where available? If standard methods are not available, will the methods used be documented?	____	x	3	=	____
2c. Does the offeror have a laboratory QC program which specifies at least 5-10 percent sample replication and 5 percent spiked sample analysis?	____	x	4	=	____
3c. Is high quality analytical instrumentation available for use on the project?	____	x	2	=	____
4c. Are laboratory facilities adequate?	____	x	2	=	____
5c. Are analytical detection limits adequate for the purposes of the project?	____	x	2	=	____
6c. Does the offeror participate in EPA and/or other interlaboratory QC programs?	____	x	2	=	____
Total Score for Sub-element C.					____
Maximum Possible Score					75

Percent of maximum possible score awarded for Sub-element C. (circle closest value).

0% 20% 40% -- 60% 80% 100%

Score for this sub-element of the proposal evaluation criteria (circle corresponding value).

0 1 2a 2b 3 4 5

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*Appendix C provides a listing of acceptable EPA Analytical Methods.

APPENDIX A (continued)

Criteria	Scoring Value	x	Numerical Weight	=	Individual Score
D. Quality assurance procedures for data management.					
1d. Does the offeror possess appropriate data handling, processing, and retrieval capabilities?	____	x	3	=	____
2d. Will QC data (e.g., standard curves, duplicate results, spike sample results) be maintained and be accessible to the Project Officer?	____	x	3	=	____
3d. Does the organization routinely maintain analytical performance records such as quality control charts?	____	x	2	=	____
4d. Are all laboratory results and QC data reviewed by laboratory supervisory personnel?	____	x	3	=	____
5d. Are all data and records retained for a minimum of 3 years?	____	x	1	=	____
6d. Are field notebooks used to record sampling and engineering data (e.g., sample number, date/time of collection, flow, operating conditions, etc.)?	____	x	3	=	____
Total Score for Sub-element D					____
Maximum Possible Score					75

Percent of maximum possible score awarded for Sub-element D (circle closest value).

0% 20% 40% -- 60% 80% 100%

Score for this sub-element of the proposal evaluation criteria (circle corresponding value).

0 1 2a 2b 3 4 5

APPENDIX B

QUALITY CONTROL PERFORMANCE/REFERENCE TEST SAMPLES

The information contained in this Appendix consists of a listing of performance/reference test samples and their sources. In addition to those samples currently available, new materials expected to be available in FY 79 are also listed.

WATER QUALITY PARAMETERS (Available from EMSL-Ci through the QA Officer, IERL-Ci)

Mineral/Physical Analyses

Calcium
Magnesium
Sodium
Potassium
Alkalinity
Sulfate
Chloride/Fluoride
Residue, Total Filterable
Hardness, Total
pH
Conductance

Demand Analyses

Organic Carbon
Chemical Oxygen Demand
Biochemical Oxygen Demand

Nutrients

NH_3 - N
NO_3 - N
PO_4 - P
Kjeldahl - N
Phosphorous, Total

Nitrilotriacetic Acid

NTA

Trace Metals

Aluminum
Arsenic
Beryllium
Cadmium
Cobalt
Chromium
Copper
Iron
Lead
Manganese
Mercury
Nickel
Selenium
Vanadium
Zinc

Mercury (Organic & Inorganic)

Mercury, Total

Linear Alkylate Sulfonate

EPA/SDA Standard Solution, 5% Active

APPENDIX B (continued)

Residue Analysis

- Residue, Total Non-Filterable--fine particles
- Residue, Total Non-Filterable--fibrous material
- Residue, Total Non-Filterable--coarse particles

Chlorophyll

- Chlorophyll, a, b, c, and pheophytin for Spectrophotometric Analyses
- Chlorophyll, a and pheophytin for Fluorometric Analyses

Volatile Organics

- 1,2, Dichloroethane
- Chloroform
- 1,1,1 Trichloroethane
- 1,1,2 Trichloroethylene
- Carbon Tetrachloride
- 1,1,2,2 Tetrachloroethylene
- Bromodichloromethane
- Dibromochloromethane
- Bromoform

Polychlorobiphenyls

- Aroclor 1016
- Aroclor 1254

Petroleum Hydrocarbons for Characterization

- Two Crude Oils
- #2 Fuel Oil
- Bunker C

Pesticides, Chlorinated Hydrocarbon

- Aldrin
- Chlordane
- Dieldrin
- Heptachlor
- DDT
- DDD
- DDE

Acid Extracts (Phenolics)

Municipal Digested Sludge

Cyanide

Oil/Grease

Trihalomethanes

Turbidity

Free Chlorine

Base/Neutral Extracts

- Phthalates
- Nitro- and Chloro-benzenes
- PNAs
- Benzidine (Standard Only)
- 2,4-Dinitrotoluene
- 2,6-Dinitrotoluene
- Isophorone
- Nitrobenzene
- Acenaphthene
- 1,2,4-Trichlorobenzene
- Hexachlorobenzene
- Hexachloroethane
- 2-Chloronaphthalene
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- Fluoranthene
- Hexachlorobutadiene
- Hexachlorocyclopentadiene
- Naphthalene
- Dimethylphthalate
- Diethylphthalate
- Di-n-butylphthalate
- Butylbenzylphthalate
- bis(2-ethylhexyl)phthalate
- 1,2-Benzanthracene
- Benzo(a)pyrene
- Chrysene
- Acenaphthylene
- Anthracene
- 1,12-Benzoperylene
- Fluorene
- Phenanthrene
- 1,2,5,6 Dibenzanthracene
- Indeno(1,2,3 c,d)pyrene
- Pyrene

WATER SUPPLY QC SAMPLES (Available from QA Coordinators through QA Officer, IERL-Ci)

Metals

- Arsenic
- Barium
- Cadmium
- Chromium
- Lead
- Mercury
- Selenium
- Silver

Nitrate/Fluoride

Trihalomethanes

Pesticides

- Endrin
- Lindane
- Methoxychlor
- Toxaphene

Herbicides

- 2,4 D
- 2,4,5-TP Silvex

PRIORITY POLLUTANTS (Available from EMSL through QA Officer, IERL-Ci)

Pesticides

- Toxaphene
- Chlordane
- Endrin
- Heptachlor
- Aldrin
- Dieldrin
- 4,4-DDT
- 4,4-DDE
- 4,4-DDD
- BHC

PRIORITY POLLUTANTS (continued)

Aroclors

- PCB-1016
- PCB-1254

Purgeable Compounds

- Benzene
- Carbon Tetrachloride
- Chlorobenzene
- 1,2-Dichloroethane
- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1,2-Trichloroethane
- 1,1,2,2-Tetrachloroethane
- Chloroform
- 1,1-Dichloroethylene
- 1,2-trans-Dichloroethylene
- 1,2-Dichloropropane
- 1,3-Dichloropropylene
- Ethylbenzene
- Methylene chloride
- Bromoform
- Dichlorobromomethane
- Trichlorofluoromethane
- Tetrachloroethylene
- Toluene
- Trichloroethylene
- o, m, and p Xylene

APPENDIX B (continued)

RADIATION (Available from EMSL--Las Vegas through QA Officer, IERL-Ci)

Water

gross α
gross β
γ (Cr^{51}, Zn^{65}, Co^{60}, Ru^{106}, $Cs^{134,137}$)
H^3
Pu^{239}
$Ra^{226,228}$
$Sr^{89,90}$

Water Laboratory Certification Samples

Blind Sample

Milk

$Sr^{89,90}$, I^{131}, Cs^{137}, Ba^{140}

Air

gross α, gross β, Cs^{137} and Sr^{90}

Soil

$Pu^{238,239}$, $Th^{228,230,232}$

Diet

$Sr^{89,90}$, I^{131}, Cs^{137}, Ba^{140} and K

Urine

H^3

Gas

Kr^{85}

AIR PARAMETERS (Available from EMSL--RTP through QA Officer, IERL-Ci)

NO_2 (ambient)
SO_2 (ambient)
SO_4/NO_3 (glass-fiber filter)
NH_4SO_4 (glass-fiber and teflon filter)
Pb (glass-fiber and membrane filter)
As (glass-fiber filter)

AIR PARAMETERS (continued)

NO (cylinders, 3 levels)
NO_2 (cylinders)
SO_2 (cylinders)
CO (cylinders, 3 levels)
CH_4 (cylinders, 9 levels)
Zero Air (for HC and NO_x)
SO_2 (source)
NO_x (source)
Benzene (cylinders, 2 levels)
Ethylene (cylinders, 3 levels)
Methane/Ethane (cylinders, 4 levels
Propane (cylinders, 2 levels)
Propylene (cylinders, 2 levels)
Toluene (cylinders, 2 levels)
Methyl Acetate (cylinders, 2 levels
Vinyl Chloride (cylinders, 2 levels
Hydrogen Sulfide (cylinders, 3 levels
m-Xylene (cylinders, 2 levels)
Chloroform (cylinders, 2 levels)
Perchloroethylene (cylinders, 2 levels)
Butadiene (cylinders)
Carbonyl Sulfide (cylinders, 4 levels)
Hexane (cylinders, 4 levels)
Methyl Mercaptan (cylinders, 4 levels)
Methyl Ethyl Ketone (cylinders)
Trichloroethylene (cylinders, 2 levels)
Vinylidene Chloride (cylinders, 2 levels)
1,2 Dichloroethane (cylinders, 2 levels)
Acetaldehyde (cylinders, 2 levels)
Propylene Dichloride (cylinders, 2 levels)
1,2 Dibromoethylene (cylinders 2 levels)
Acrylonitrile (cylinders, 2 levels)
Cyclohexane (cylinders)
Methanol (cylinders)

APPENDIX C
EPA ACCEPTED ANALYTICAL METHODS

TABLE C-1. WATER QUALITY MEASUREMENT METHODS

Parameter	Method	Reference*
Acidity, as $CaCO_3$, mg/l	Electrometric end point (pH of 8.2) or phenolphthalein end point	1, 2, 3, 4
Alkalinity, as $CaCO_3$, mg/l	Electrometric titration (only to pH 4.5) manual or automated, or equivalent automated methods	1, 2, 3, 4
Ammonia (as N), mg/l	Manual distillation (at pH 9.5) followed by nesslerization, titration, electrode, Automated phenolate	1, 2, 3, 4
Bacteria		
Coliform (fecal), no./100 ml	MPN; membrane filter	2, 4
Coliform (total), no./100 ml		2, 4
Fecal streptococci, no./100 ml	MPN; membrane filter, plate count	2, 4
Benzidine, mg/l	Oxidation--colorimetric	5
Biochemical oxygen demand 5-d (BOD_5), mg/l	Winkler (Azide modification) or electrode method	2, 4
Bromide, mg/l	Titrimetric, iodine-iodate	1, 3, 4
Chemical oxygen demand (COD), mg/l	Dichromate reflux	1, 2, 3, 4
Chloride, mg/l	Silver nitrate; mercuric nitrate; or automated colorimetric-ferricyanide	1, 2, 3, 4
Chlorinated organic compounds (except pesticides), mg/l	Gas chromatography	6
Chlorine--total residual, mg/l	Iodometric titration, amperometric or starch-iodine end-point; DPD colorimetric or Titrimetric methods (these last 2 are interim methods pending laboratory testing)	1, 2, 3
Color, platinum cobalt units or dominant wavelength, hue, luminance, purity	Colorimetric; spectrophotometric; or ADMI procedure	1, 2, 4

(continued)

TABLE C-1. WATER QUALITY MEASUREMENT METHODS (Continued)

Parameter	Method	Reference*
Cyanide, total, mg/l	Distillation followed by silver nitrate titration or pyridine pyrazolone (or barbituric acid) colorimetric	1, 2, 3, 4
Dissolved oxygen, mg/l	Winkler (Azide modification) or electrode method	1, 2, 3, 4
Fluoride, mg/l	Distillation followed by ion electrode; SPADNS; or automated complexone	1, 2, 3, 4
Hardness--total, as $CaCO_3$, mg/l	EDTA titration; automated colorimetric; or atomic absorption (sum of Ca and Mg as their respective carbonates)	1, 2, 3, 4
Hydrogen ion (pH), pH units	Electrometric measurement	1, 2, 3, 4
Kjeldahl nitrogen (as N), mg/l	Digestion and distillation followed by nesslerization, titration, or electrode; automated digestion automated phenolate	1, 2, 4
Metals		
All dissolved metals	0.45 micron filtration[7] followed by referenced method for total metal	1, 2, 4
Aluminum--total, mg/l	Digestion[8] followed by atomic absorption[9] or by colorimetric (Eriochrome Cyanine R)	1, 2, 4
Antimony--total, mg/l	Digestion[8] followed by atomic absorption[9]	1
Arsenic--total, mg/l	Digestion followed by silver diethyldithiocarbamate; or atomic absorption[9]	1, 2, 4
Barium--total, mg/l	Digestion[8] followed by atomic absorption[9]	1, 2, 4
Beryllium--total, mg/l	Digestion[8] followed by atomic absorption[9] or by colorimetric (Aluminon)	1, 2, 4
Boron--total, mg/l	Corimetric (Curcumin)	1, 2

(continued)

TABLE C-1. WATER QUALITY MEASUREMENT METHODS (Continued)

Parameter	Method	Reference*
Cadmium--total, mg/l	Digestion[8] followed by atomic absorption[9] or by colorimetric (Dithizone)	1, 2, 3, 4
Calcium--total, mg/l	Digestion[8] followed by atomic absorption; or EDTA titration	1, 2, 3, 4
Chromium VI, mg/l	Extraction and atomic absorption; colorimetric (Diphenylcarbazide)	1, 2, 4
Chromium--total, mg/l	Digestion[8] followed by atomic absorption[9] or by colorimetric (Diphenylcarbazide)	1, 2, 3, 4
Cobalt--total, mg/l	Digestion[8] followed by atomic absorption[9]	1, 2, 3, 4
Copper--total, mg/l	Digestion[8] followed by atomic absorption[9] or by colorimetric (Neocuproine)	1, 2, 3, 4
Gold--total, mg/l	Digestion[8] followed by atomic absorption[9]	
Iridium--total, mg/l	Digestion[8] followed by atomic absorption[9]	
Iron--total, mg/l	Digestion[8] followed by atomic absorption[9] or by colorimetric (Phenanthroline)	1, 2, 3, 4
Lead--total, mg/l	Digestion[8] followed by atomic absorption[9] or by colorimetric (Dithizone)	1, 2, 3, 4
Magnesium--total, mg/l	Digestion[8] followed by atomic absorption[9] or gravimetric	1, 2, 3, 4
Manganese--total, mg/l	Digestion[8] followed by atomic absorption[9] or by colorimetric (Persulfate or periodate)	1, 2, 3, 4
Mercury--total, mg/l	Flameless atomic absorption	1, 2, 3, 4
Molybdenum--total, mg/l	Digestion[8] followed by atomic absorption[9]	1, 3
Nickel--total, mg/l	Digestion[8] followed by atomic absorption[9] or by colorimetric (Heptoxime)	1, 2, 3, 4
Osmium--total, mg/l	Digestion[8] followed by atomic absorption[9]	

(continued)

TABLE C-1. WATER QUALITY MEASUREMENT METHODS (Continued)

Parameter	Method	Reference*
Palladium--total, mg/l	Digestion[8] followed by atomic absorption[9]	
Platinum--total, mg/l	Digestion[8] followed by atomic absorption[9]	
Potassium--total, mg/l	Digestion[8] followed by atomic absorption, colorimetric (Cobaltinitrite), or by flame photometric	1, 2, 3, 4
Rhodium--total, mg/l	Digestion[8] followed by atomic absorption[9]	
Ruthenium--total, mg/l	Digestion[8] followed by atomic absorption[9]	
Selenium--total, mg/l	Digestion[8] followed by atomic absorption[9]	1, 2
Silica--dissolved, mg/l	0.45 micron filtration[7] followed by colorimetric (Molybdosilicate)	1, 2, 3, 4
Silver--total, mg/l	Digestion[8] followed by atomic absorption[9] or by colorimetric (Dithizone)	1, 2, 4
Sodium--total, mg/l	Digestion[8] followed by atomic absorption or by flame photometric	1, 2, 3, 4
Thallium--total, mg/l	Digestion[8] followed by atomic absorption[9]	1
Tin--total, mg/l	Digestion[8] followed by atomic absorption[9]	1, 4
Titanium--total, mg/l	Digestion[8] followed by atomic absorption[9]	1
Vanadium--total, mg/l	Digestion[8] followed by atomic absorption[9] or by colorimetric (Gallic acid)	1, 2, 3, 4
Zinc--total, mg/l	Digestion[8] followed by atomic absorption[9] or by colorimetric (Dithizone)	1, 2, 3, 4
Nitrate (as N), mg/l	Cadmium reduction; brucine sulfate; automated cadmium or hydrazine reduction[10]	1, 2, 3, 4
Nitrite (as N), mg/l	Manual or automated colorimetric (Diazotization)	1, 2, 4
Oil and grease, mg/l	Liquid-liquid extraction with trichloro-trifluoroethane-gravimetric	1, 2

(continued)

TABLE C-1. WATER QUALITY MEASUREMENT METHODS (Continued)

Parameter	Method	Reference
Organic carbon--total (TOC), mg/l	Combustion--infrared method[11]	1, 2, 3
Organic nitrogen (as N), mg/l	Kjeldahl nitrogen minus ammonia nitrogen	1, 2, 4
Orthophosphate (as P), mg/l	Manual or automated ascorbic acid reduction	1, 2, 3, 4
Pentachlorophenol, mg/l	Gas chromatography[6]	2, 3
Pesticides, mg/l	6	
Phenols, mg/l	Distillation followed by colorimetric (4AAP)	1, 2, 3
Phosphorus (elemental), mg/l	Gas chromatography	12
Phosphorus--total (as P), mg/l	Persulfate digestion followed by manual or automated ascorbic acid reduction	1, 2, 3, 4
Radiological		
Alpha--total, pCi per liter	Proportional or scintillation counter	2, 3, 4
Alpha--counting error, pCi per liter		2, 3, 4
Beta--total, pCi per liter	Proportional counter	2, 3, 4
Beta--counting error, pCi per liter		2, 3, 4
Radium--total, pCi per liter		2, 3
Ra, pCi per liter	Scintillation counter	1, 4
Residue		
Total, mg/l	Gravimetric, 103 to 105°C	1, 2
Total dissolved (filterable), mg/l	Glass fiber filtration, 180°C	1, 2
Total suspended (nonfilterable), mg/l	Glass fiber filtration, 103 to 105°C	1, 2
Settleable, ml/l or mg/l	Volumetric or gravimetric	2
Total volatile, mg/l	Gravimetric, 550°C	1, 2
Specific conductance, micromhos per centimeter at 25°C	Wheatstone bridge conductimetry	1, 2, 3, 4

(continued)

TABLE C-1. WATER QUALITY MEASUREMENT METHODS (Continued)

Parameter	Method	Reference*
Sulfate (as SO_4), mg/l	Gravimetric; turbidimetric; or automated colorimetric (barium chloranilate)	2, 3
Sulfide (as S), mg/l	Titrimetric--iodine for levels greater than 1 mg per liter; Methylene blue photometric	1, 3, 4
Sulfite (as SO_3), mg/l	Titrimetric, iodine-iodate	1, 2, 3
Surfactants, mg/l	Colorimetric (Methylene blue)	1, 2, 3, 4
Temperature, °C	Calibrated glass or electrometric thermometer	1, 2, 4
Turbidity, NTU	Nephelometric	1, 2, 3, 4

*References:

[1] Methods for Chemical Analysis of Water and Wastes. 1979. U.S. Environmental Protection Agency. Office of Research and Development. Environmental Monitoring and Support Laboratory. Cincinnati, Ohio.

[2] Standard Methods for the Examination of Water and Wastewater, 14th edition. 1975. American Public Health Association, American Water Works Association and Water Pollution Control Federation. Washington, D.C.

[3] Annual Book of ASTM Standards, Part 31: Water. 1978. American Society for Testing and Materials. Philadelphia, Pennsylvania.

[4] All references for USGS methods, unless otherwise noted, are to Brown, E., Skougstad, M.W., and Fishman, M.J., "Methods for Collection and Analysis of Water Samples for Dissolved Minerals and Gases." U.S. Geological Survey Techniques of Water-Resources Inv., Book 5, Ch. A1 (1970).

TABLE C-1. WATER QUALITY MEASUREMENT METHODS (Continued)

[5] Adequately tested methods for benzidine are not available. Until approved methods are available, the following interim method can be used for the estimation of benzidine: (1) "Method for Benzidine and Its Salts in Wastewaters," available from Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[6] Procedures for pentachlorophenol, chlorinated organic compounds, and pesticides can be obtained from the Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[7] Dissolved metals are defined as those constituents which will pass through a 0.45 um membrane filter. A prefiltration is permissible to free the sample from larger suspended solids. Filter the sample as soon as practical after collection using the first 50 to 100 ml to rinse the filter flask. (Glass or plastic filtering apparatus are recommended to avoid possible contamination.) Discard the portion used to rinse the flask and collect the required volume of filtrate. Acidify the filtrate with 1:1 redistilled HNO_3 to a pH of 2. Normally, 3 ml of (1:1) acid per liter should be sufficient to preserve the samples.

[8] For the determination of total metals the sample is not filtered before processing. Because vigorous digestion procedures may result in a loss of certain metals through precipitation, a less vigorous treatment is recommended as given on page 83 (4.1.4) of "Methods for Chemical Analysis of Water and Wastes" (1974). In those instances where a more vigorous digestion is desired, the procedure on page 82 (4.1.3) should be followed. For the measurement of the noble metal series (gold, iridium, osmium, palladium, platinum, rhodium, and ruthenium), an aqua regia digestion is to be substituted as follows: Transfer a representative aliquot of the well-mixed sample to a Griffin beaker and add 3 ml of concentrated redistilled HNO_3. Place the beaker on a steam bath and evaporate to dryness. Cool the beaker and cautiously add a 5 ml portion of aqua regia. (Aqua regia is prepared immediately before use by carefully adding 3 volumes of concentrated HCl to one volume of concentrated HNO_3). Cover the beaker with a watch glass and return to the steam bath. Continue heating the covered beaker for 50 min. Remove cover and evaporate to dryness. Cool and take up the residue in a small quantity of 1:1 HCl. Wash down the beaker walls and watch glass with distilled water and filter the sample to remove silicates and other insoluble material that could clog the atomizer. Adjust the volume to some predetermined value based on the expected metal concentration. The sample is now ready for analysis.

(continued)

TABLE C-1. WATER QUALITY MEASUREMENT METHODS (Continued)

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[9] As the various furnace devices (flameless AA) are essentially atomic absorption techniques, they are considered to be approved test methods. Methods of standard addition are to be followed as noted in page 78 of "Methods for Chemical Analysis of Water and Wastes," 1974.

[10] An automated hydrazine reduction method is available from the Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

[11] Goerlitz, D., Brown, E., "Methods for Analysis of Organic Substances in Water": U.S. Geological Survey Techniques of Water-Resources Inv., book 5, ch. A3 (1972).

[12] R.F. Addison and R.G. Ackman, "Direct Determination of Elemental Phosphorus by Gas-Liquid Chromatography," "Journal of Chromatography," vol. 47, No. 3, pp. 421-426, 1970.

TABLE C-2. DRINKING WATER MEASUREMENT METHODS

Parameter	Method	Reference
Organics (a) Chlorinated Hydrocarbons: Endrin Lindane Methoxychlor Toxaphene	Gas chromatography with electron capture detector	Methods for Organochlorine Pesticides in Industrial Effluents, MDQARL, EPA, Cincinnati, Ohio, 1973
(b) Cholorophenoxys: 2,4-Dichlorophenoxyacetic acid 2,4,5-Trichlorophenoxypropionic acid		Methods for Chlorinated Phenoxy Acid Herbicides in Industrial Effluents, MDQARL, EPA, Cincinnati, Ohio, 1973
Radiation		Code of Federal Regulations, 40(Parts 100 to 399): 169-197
Inorganic Chemicals		Code of Federal Regulations, 40(Parts 100 to 399): 169-197
Physical Measurements		Code of Federal Regulations, 40(Parts 100 to 399): 169-197
Microbiological Measurements		Code of Federal Regulations, 40(Parts 100 to 399): 169-197

TABLE C-3. AMBIENT AIR MEASUREMENT METHODS

Pollutant	Measurement method or principle	Reference
Suspended Particulates	High volume sampler Tape sampler	CFR 40, Part 50, Appendix B, July 1, 1979
Sulfur Dioxide	Pararosaniline or equivalent	CFR 40, Part 50, Appendix A, July 1, 1979
Carbon Monoxide	Nondispersive infrared or equivalent	CFR 40, Part 50, Appendix C, July 1, 1979
Photochemical Oxidants	Gas phase chemiluminescence or equivalent	CFR 40, Part 50, Appendix D, July 1, 1979
Nitrogen Dioxide	Gas phase chemiluminescence or equivalent	CFR 40, Part 50, Appendix F, July 1, 1979

TABLE C-4. SOURCE AIR METHODS

Determination	Description of method	Reference
Sample and Velocity Traverses for Stationary Sources		EPA Method 1 Environmental Protection Agency Performance Test Methods, page I-1, EPA-340/1-78-011
Stack Gas Velocity	Pitot	EPA Method 2 I-13
Dry Molecular Weight of Gas	Orsat	EPA Method 3 I-45
Stack Gas Moisture	Volumetric & Gravimetric	EPA Method 4 I-61
Particulate Emissions	Gravimetric	EPA Method 5 I-79
Sulfur Dioxide	Collection by impinger, analysis by barium perchlorate titration	EPA Method 6 I-119
Nitrogen Oxide	Collection by evacuated flask, colorimetric analysis	EPA Method 7 I-135
Sulfuric Acid Mist and Sulfur Dioxide	Collection by impinger, analysis by barium perchlorate titration	EPA Method 8 I-157
Visible Emissions	Certified observer	EPA Method 9
Carbon Monoxide	Non-dispersive infrared	EPA Method 10
Hydrogen Sulfide	Collection by impinger, iodimetric titration	EPA Method 11

(continued)

TABLE C-4. SOURCE AIR METHODS (Continued)

Determination	Description of method	Reference
Fluoride	Collection by impinger, colorimetric, or specific ion electrode	EPA Method 13A (Colorimetric) or 13B (Specific Ion Electrode)
Sulfur Compounds	Gas chromatographic determination of sulfur gases emitted by a Claus Sulfur Recovery Unit	EPA Method 15
Sulfur Compounds	Gas chromatographic determination of reduced sulfur compounds emitted by paper mills	EPA Method 16
Particulate Matter	In-stack filter determination of particulate matter	EPA Method 17

TABLE C-5. PRIORITY POLLUTANT MEASUREMENT METHODS

Recommended analytical methods for priority pollutants are described in "Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants".

These guidelines for sampling and analysis of industrial wastes have been prepared by the staff of the Environmental Monitoring and Support Laboratory - Cincinnati, at the request of the Effluent Guidelines Division, Office of Water and Hazardous Wastes, and with the cooperation of the Environmental Research Laboratory, Athens, Georgia. The procedures represent the current state of the art, but improvements are anticipated as more experience with a wide variety of industrial wastes is obtained. Users of these methods are encouraged to identify problems encountered and to assist in updating the test procedures by contacting the Environmental Monitoring and Support Laboratory, EPA, Cincinnati, Ohio 45268. These methods were first made available in March 1977 and were revised in April 1977.

TABLE C-6. RADIATION MEASUREMENT METHODS

Parameter and units	Method	Sample matrix	Reference
Alpha - total pCi per liter	Proportional or scintillation counter	Water	Interim Radiochemical Methodology for Drinking Water EPA-600/4-75-008 Standard Methods for the Examination of Water and Wastewater, 14th Ed.
Beta - total pCi per liter	Proportional counter	Water	(same as above)
Radium-226 - pCi per liter	Scintillation counter	Water	(same as above)
Strontium 89, 90 - pCi per liter		Water	(same as above)
Tritium - pCi per liter		Water	(same as above)
Cesium 134 - pCi per liter		Water	(same as above) ASTM D-2459 Gamma Spectroscopy in Water, 1975
Uranium - pCi per liter	Fluorometric	Water	ASTM D-2907 Micro Quantities of Uranium in Water by Fluorimetry, 1975
Others (various units depending on media)		Various	HASL Procedure Manual, HASL 300, ERDA Health and Safety Laboratory, New York, NY, 1973

APPENDIX D

QUALITY ASSURANCE PROGRAM CHECKLIST

Contractors and grantees must follow accepted quality assurance procedures to establish the quality of sampling and analytical data which are used in IERL-Ci programs. Each organization should have written QA procedures which describe the routine steps taken to guarantee, to the extent possible, the quality of all sampling and analytical data reported by the laboratory. The purpose of this checklist is to provide guidance to the Project Officer in reviewing the QA program of a contractor or grantee in order to determine if it is in general conformance with IERL-Ci requirements. The questions in this checklist address each major area of quality assurance that should be encompassed by a comprehensive or "model" QA program.

This checklist applies to a contractor's general Quality Assurance manual which encompasses all aspects of work performed by the contractor. It should be used to check the contractor's overall QA program to establish that all QA aspects are discussed. This checklist should be completed before project work begins.

This checklist differs from Appendix E in that it covers the contractor's overall QA program and philosophy. Appendix E is the checklist to be used in determining whether any weakness exists in the Quality Assurance as applied to any specific work plan the contractor may submit.

This checklist should be completed by the Project Officer.

APPENDIX D (Continued)

QUALITY ASSURANCE PROGRAM CHECKLIST

GENERAL INFORMATION

Laboratory: ____

Street Address: ____

Mailing Address (If Different): ________________________

City ____________________ State __________________ Zip ________

Laboratory Telephone No.: Area Code ____________ No. ________________

Laboratory Director: ___________________________________

Project Manager: _______________________________________

Contract/Grant Number: _________________________________

Contract/Grant Title: __________________________________

Project Officer: _______________________________________

Review Conducted By: ___________________________________

Agency and Address: ____________________________________

____

____

Telephone No.: Area Code __________ No. ____________________

______________________________ Reviewer Signature

__________ Date

QA manual returned to contractor/grantee ___________ (Date).

APPENDIX D (Continued)

QA POLICY AND OBJECTIVES

Item	Yes	No	Comment
Does the organization maintain written QA procedures which describe the routine steps taken to assure the quality of sampling and analytical data?			
Is tnere a clear statement of quality objectives by top management levels?			
Does the organization have a stated QA policy consistent with the program requirements of IERL-Ci?			
Are QA plans required for all major projects or programs requiring extensive sampling and/or analysis?			
Does the appearance, format, and content of the QA program manual(s) reflect a conscientious concern for the quality of data produced by the organization?			

QA ORGANIZATION

Item	Yes	No	Comment
Are QA responsibilities and reporting relationships within the organization clearly defined?			
Does the QA program provide for a QA Supervisor and are his responsibilities and authority defined?			
Does the QA Supervisor have access to senior levels of management?			
Are the QA-related responsibilities of laboratory and field sampling personnel clearly defined?			

APPENDIX D (Continued)

PERSONNEL TRAINING

Item	Yes	No	Comment
Has the designated QA Supervisor had formal training in QA procedures (e.g., the EPA training course offered by EPA-Ci or EPA-Athens)?			
Is there a training program for sampling personnel?			
Is there a training program for laboratory personnel?			
Does the training program go beyond "on the job training" to include practice tasks, seminars, instruction sessions, etc.?			

DOCUMENT CONTROL AND REVISION

Item	Yes	No	Comment
Are there established procedures for documenting sampling methods and for updating these methods when required?			
Are there established procedures for documenting analytical methods and for updating these methods when required?			
Is there a system for documenting instrument calibration procedures?			
Does the QA program require documentation of all computer programs that are used to calculate or process data?			
Are "standard" analytical methods used whenever available and appropriate?			

APPENDIX D (Continued)

FACILITIES AND EQUIPMENT

PROCUREMENT AND INVENTORY PROCEDURES

Item	Yes	No	Comment
Does the organization have procedures for procurement quality control for reagents, glassware, etc.?			
Are analytical reagents dated upon receipt?			
Are reagent inventories maintained on a first-in, first-out basis?			
Are analytical reagents checked out before use?			
Is new analytical instrumentation tested before use?			

PREVENTIVE MAINTENANCE

Item	Yes	No	Comment
Does the laboratory have a preventive maintenance program or schedule for laboratory instrumentation?			
Does the QA program require the maintenance of instrument log books and specify their general content?			
Are preventive maintenance activities documented in instrument log books?			

APPENDIX D (Continued)

ANALYTICAL METHODOLOGY

CALIBRATION AND OPERATION PROCEDURES

Item	Yes	No	Comment
Are general instrument calibration requirements described in the QA program?			
Does the QA program specify that calibration standards should be traceable to primary (e.g., NBS) standards that are available?			
Are instrument calibration data recorded in instrument log books?			
Are acceptability requirements established for instrumentation?			
Have instrument calibration schedules been established?			

FEEDBACK AND CORRECTIVE ACTION

Item	Yes	No	Comment
Does the QA program clearly state who is responsible for taking corrective action when analytical problems are encountered?			
Are corrective action follow-up procedures described?			
Are corrective actions documented?			

APPENDIX D (Continued)

SAMPLING AND SAMPLE HANDLING PROCEDURES

CONFIGURATION CONTROL

Item	Yes	No	Comment
Are procedures described for configuration control of monitoring systems such as air monitors, water quality monitors, flow monitors?			
If an air or water pollution monitor is relocated, would this be recorded in project files?			

SYSTEMS RELIABILITY

Item	Yes	No	Comment
Are procedures described for maintaining the reliability of data generating equipment and instrumentation?			
Do QA procedures require the documentation of system reliability (e.g., percent uptime, percent reliable data, etc.)?			
Are reliability data used in revising maintenance and/or instrument replacement schedules?			

QUALITY CONTROL

QUALITY CONTROL PROCEDURES

Item	Yes	No	Comment
Is duplicate analysis required on a minimum of 5 to 15 percent of all samples?			
Have acceptance criteria been established for the precision of duplicate analysis results?			
Are spiked sample analyses required on a routine basis (e.g., 5 percent of samples) to determine analytical recoveries?			
Have acceptance criteria been established for spiked sample results?			
Are quality control charts used to monitor analyst performance on routine analyses?			
Are reagent blank analyses run with each set of samples?			
Are split sample analyses used as part of the quality control program?			
Are a minimum of three and preferably more standards required for standard curves?			
Do routine procedures require that standard curves bracket sample concentrations?			

APPENDIX D (Continued)

CONTROL CHECKS AND INTERNAL AUDITS

Item	Yes	No	Comment
Does the QA Supervisor or other supervisory personnel audit laboratory procedures on a routine, periodic basis?			
If keypunching is required, have procedures been established to identify keypunch errors?			
Does the laboratory routinely use available EPA reference test samples and/or standard reference materials available from other sources (e.g., NBS) to evaluate analytical performance?			
Are reference test samples used to evaluate analytical performance at least semi-annually?			
Are the results of intralaboratory performance tests maintained by the QA Supervisor and used to improve analytical performance?			
Are reference test samples routinely prepared and submitted to the analyst as "blind" samples?			
Does the laboratory participate in interlaboratory performance tests?			
Are field sampling procedures audited at periodic intervals by the QA Supervisor or other supervisory personnel?			

APPENDIX D (Continued)

DATA HANDLING

DATA HANDLING, REPORTING, AND RECORDKEEPING

Item	Yes	No	Comment
Are procedures described for the proper handling, routing, and reviewing of field and laboratory data?			
Is each sample assigned a unique identification number upon collection?			
Are laboratory notebooks used to record vital operational information?			
Are laboratory bench data reported in a clear, logical format which permits review and confirmation of calculations?			
Are procedures described for the accurate and complete labeling of strip charts?			
Are field notebooks required for all field data and observations?			
Is the general content of field notebooks specified?			
Are field notebook entries reviewed by supervisory personnel?			
Are field notebooks signed by the individual recording the information and by reviewers?			
Are sample chain-of-custody procedures described?			
Are QA reports routinely prepared for management review?			
Are all data and records retained a minimum of three years?			

DATA VALIDATION

Item	Yes	No	Comment
Does the QA program require routine cross-checking of manual data calculations?			
Are supervisory personnel required to review all laboratory data?			
Are acceptance criteria established for laboratory data?			
Are data collected by on-line or *in situ* systems routinely checked for consistency and accuracy?			
Are computer programs validated before use?			
Are data validation activities recorded for future reference?			
Does the QA program describe the handling of invalid data?			

APPENDIX D (Continued)

Overall, does the QA program described in the document reviewed meet the QA program requirements of IERL-Ci? ______ Yes ______ No

Describe where the QA program departs from IERL-Ci requirements and explain what corrective action, if any, is necessary.

APPENDIX E

PROJECT QUALITY ASSURANCE CHECKLIST

This checklist has been prepared to assist Project Officers in reviewing project work plans or study plans with respect to sampling and analytical quality assurance. The checklist is not comprehensive; it does not address all factors that would affect the quality of the sampling and analytical data on all projects. It does, however, represent the type of detail that should be included in a well-written Project Work Plan. The use of this checklist in reviewing project work plans should allow the Project Officer to judge the adequacy of proposed quality assurance procedures.

This checklist applies to a contractor's specific work plan as applied to a project or task. It should be used to insure that the contractor has prepared a work plan which includes sufficient quality assurance to complete the project in a satisfactory manner.

Appendix E differs from Appendix D in that it applies specifically to a project or task, whereas the checklist in Appendix D applies to the contractor's general Quality Assurance Program.

This checklist should be completed by the Project Officer.

APPENDIX E (Continued)

PROJECT QUALITY ASSURANCE CHECKLIST

GENERAL INFORMATION

Laboratory: ________________________________

Street Address: ________________________________

Mailing Address (If Different): ________________________

City ____________ State ____________ Zip ______

Laboratory Telephone No.: Area Code ________ No. ____________

Laboratory Director: ________________________________

Project Manager: ________________________________

Contract/Grant Number: ________________________________

Contract/Grant Title: ________________________________

Project Officer: ________________________________

Review Conducted By: ________________________________

Agency and Address: ________________________________

____

____

Telephone No.: Area Code ________ No. ____________

________________________ ________
Reviewer Signature Date

QA manual returned to contractor/grantee ________.
Date

PROJECT OBJECTIVES

Item	Yes	No	Comment
Is a clear statement made of the objectives of the project and the use of the sampling and analysis data?			
Has a statement been made, or can the level of importance to be attached to the QA considerations be derived from stated project objectives?			

PROJECT STAFFING

Item	Yes	No	Comment
Has a project QA Supervisor been assigned to the project team?			
Is the project organization structure appropriate to accomplish the QA objectives of the project?			
Do personnel assigned to this project have the appropriate educational background to successfully accomplish project objectives?			
If any special training or experience is required, is it represented on the project staff?			
Will the training of personnel be required specifically for this project? If so, is it covered in the project plan?			
Is there adequate staffing to accomplish the planned work in a high-quality manner within the project schedule?			

APPENDIX E (Continued)

FACILITIES, EQUIPMENT, AND INSTRUMENTATION

Item	Yes	No	Comment
Is appropriate and adequate sampling equipment available?			
Will appropriate sample containers be used for the parameters measured?			
If *in situ*, on-line, or monitoring instrumentation is to be used, is it clearly specified as to make, model, and performance specifications?			
Are the performance specifications of all on-line or *in situ* instrumentation adequate to meet project reliability and data quality requirements?			
Has a plan been made to optimize system reliability by requiring periodic performance checks, calibration, and preventive maintenance?			
Are procedures described for documenting and controlling the configuration of all systems?			
Is laboratory instrumentation and equipment suitable to meet the data quality needs of the project?			

SAMPLING PLAN AND METHODS

Item	Yes	No	Comment
Are sampling procedures described in detail?			
Will standard sampling methods be used where available?			
Are precautions described to avoid sample contamination?			

APPENDIX E (Continued)

SAMPLING PLAN AND METHODS (continued)

Item	Yes	No	Comment
Are site or system diagrams included which show clearly and precisely the location of sample collection?			
Will any samples be taken in duplicate in order to define sampling variability?			
Are background samples to be taken?			
Is sampling frequency adequate and appropriate to the purposes of the project?			
Is the sampling program assigned to assure all samples are representative of the source?			
Will field notebooks be used to record important observations and on-site data?			
Will field data or system data be verified by supervisory personnel on a routine basis?			
Do sampling plans allow for delivery of the samples to the laboratory in time to meet maximum holding time limitations?			
Will the samples be preserved? If so, will EPA-accepted preservation methods be used?			
If any new sampling methods are to be used, will they be adequately tested before use?			

APPENDIX E (Continued)

ANALYTICAL PLAN AND METHODS

Item	Yes	No	Comment
Will standard analytical (EPA-approved) procedures be used where appropriate and available?			
Does the project plan include a copy of all non-standard analytical procedures?			
If any new analytical procedures are to be used, will they be adequately tested before use?			
Will use of the analytical methods specified result in data of adequate detection limit, accuracy, and precision to meet the requirements of the project?			
Will duplicate analyses be conducted on at least 10 percent of the samples?			
Will spike sample analyses be conducted on at least 5 percent of the samples?			
Will reagent blank samples be run?			
Will split sample analysis be conducted?			
Will any field spiked samples be processed?			
Will instruments and measurement systems be calibrated with adequate frequency (at least daily)?			
Will calibration materials that are traceable to NBS standards be used where available?			

APPENDIX E (Continued)

DATA MANAGEMENT

Item	Yes	No	Comment
Will data be validated before entering into automated data systems?			
Will automated data handling programs or computer models be adequately documented and verified before use?			
Will mathematical and computer models be verified by actual data?			
Is the statistical treatment of the data described and does it meet project requirements?			
Will a project QA report be prepared to summarize all quality control data?			

PROJECT SCHEDULE

Item	Yes	No	Comment
Does the project plan show adequate time to accomplish the sampling program, and does it allow for uncontrollable delays, such as bad weather?			
Will interim sampling and analysis program results be reported to the Project Officer for review and comment?			
Does the project schedule allow sufficient time between sample collection and reporting of the data to apply adequate analytical quality control, including supervisory review?			

APPENDIX E (Continued)

Overall, does the Project Work Plan meet the QA requirements of IERL-Ci?
______ Yes ______ No

Describe changes or improvements that should be incorporated into a revised work plan?

APPENDIX F

QUALITY ASSURANCE PRE-AUDIT WORKSHEET

The purpose of the Quality Assurance Pre-Audit Worksheet is to provide the auditing agency with information with which to familiarize itself with the project. It should be sent to the contractor, completed by the contractor, and returned before any audit trip is scheduled.

This form is to be used when the decision has been made to perform a project audit.

This checklist should be completed by the contractor's project personnel.

INSTRUCTIONS

1. It is not necessary to type your replies. Completion of the form in ink will suffice. Alternatively, appropriate sections of the project plan may be attached where appropriate.
2. You are not limited to yes and no answers. Feel free to elaborate at any point in the form.
3. Careful attention should be given to proper completion of this form since the information supplied will have a direct bearing on conclusions drawn and recommendations made concerning the evaluation of your laboratory.
4. Answer only those questions contained in the worksheet which are project specific. Indicate non-applicable questions.

APPENDIX F (Continued)

QUALITY ASSURANCE PRE-AUDIT WORKSHEET

Date ____________________

Laboratory: ____

Street Address: ____

Mailing Address (If Different): ______________________________

City ____________________ State ____________________ Zip ____________

Laboratory Telephone No.: Area Code __________ No. ____________________

Laboratory Director: ____

Quality Assurance Supervisor: ______________________________

Pre-Audit Worksheet Completed By (if more than one, please indicate which sections):

Name	Title

No. of Contract or Grant for Which Audit Is Being Performed: ____________

Title of Contract: ____

------------------------Do Not Write Below This Line------------------------

Audit to be Conducted By: ____

Agency and Address: ____
____

Telephone No.: Area Code ______________ No. ____________________

Quality Assurance Audit Scheduled On: ______________________________

A. ORGANIZATION AND PERSONNEL

A.1. Please use a simple block diagram to illustrate the structure of your organization and how the laboratory functions within it. Identify key management personnel.

ORGANIZATIONAL CHART

A.2. Please use a simple block diagram to illustrate the organization of the project sampling and sample analysis functions. Identify: key project management personnel, the quality assurance supervisor, the person directly responsible for sampling, and the person directly responsible for analyses.

PROJECT ORGANIZATIONAL CHART

APPENDIX F (continued)

A.3. PROJECT PERSONNEL

Laboratory________________________ Contract No.______________ Date____________________

Position	Name	Academic Training	Years Experience	Special Training	Responsibilities On This Project

APPENDIX F (continued)

A.4. Describe or illustrate the planned schedule for completion of the project. Show the schedule for all sampling activites and the period of time scheduled for sample analysis.

PROJECT SCHEDULE

B. FACILITIES

Instrumentation: List major instrumentation (including field instrumentation and equipment) required for the performance of this project. Prepare separate lists for radiation, chemistry, air, biology, microbiology, etc.

Item	Manufacturer	Model	Age	Condition

APPENDIX F (continued)

C. ANALYTICAL METHODOLOGY

List all laboratory methods used in the performance of this project. Use separate pages for chemistry, biology, radiation, air, microbiology, etc.

Scientific Area ____________________

Parameter	Name or Description of Method	Reference (Cite Page and Year)	Latest Reference Sample Check (Cite Agency of Origin and Date)

D. SAMPLING AND SAMPLE HANDLING PROCEDURES

D.1. Describe the sampling plan and draw a diagram indicating sampling locations, how to locate the sampling points and other pertinent information. Please indicate the scientific area (biology, radiation, chemistry, air, etc.) and use separate sheets if addressing more than one field.

Scientific Area ________________________________

D.2. Describe the information obtained in field notebooks or worksheets.

D.3. Describe sample chain-of-custody procedures employed by your laboratory.

APPENDIX F (continued)

D.4. List sample types collected, methods of preservation, etc. Please use separate pages for chemistry, biology, radiation, air, microbiology, etc.

SAMPLE COLLECTING, HANDLING, AND PRESERVATION

Scientific Area ______________________

Parameter	Container Used	Preservative Used	Normal Maximum Holding Time	Method of Transport

E. QUALITY CONTROL

E.1. Are analytical quality control records available for review?

____

E.2. Are duplicate sample analyses conducted? ____________________

If so, at what frequency? ____________________

E.3. Are spiked (recovery) sample analyses conducted? ____________________

If so, at what frequency? ____________________

E.4. Are performance test samples analyzed? ____________________

If so, how often? ____________________

E.5. Are quality control charts maintained? ____________________

E.6. Does the laboratory have a Quality Assurance Manual? ____________________

If so, is it available for review? ____________________

E.7. Does each analyst have access to approved and documented analytical procedures? ____________________

E.8. Has a quality assurance plan been prepared for the sampling required by this project? ____________________

E.9. How are quality control data used? ____________________

____

____

____

____

____

F. DATA HANDLING

F.1. How long are laboratory records and field data retained after completion of a project? ______________________________

F.2. Have procedures been established for cross-checking laboratory calculations? ____________________

F.3. Have procedures been established for cross-checking reported data?

____

F.4. Are laboratory data reviewed by supervisory personnel? __________

APPENDIX G

INSTRUMENTATION, EQUIPMENT, AND PERSONNEL SKILL RATING FOR SPECIFIC METHODS

The arbitrary rating numbers used in this appendix for the degree of skills required are:

Rating 1--A semi-skilled sub-professional with limited background

Rating 2--An experienced aide (sub-professional) with a background in general laboratory techniques and some knowledge of chemistry, or a professional with modest training or experience

Rating 3--Requires a good background in analytical techniques

Rating 4--Requires an individual with experience on complex instrumentation, some degree of specialization, and the ability to interpret results

Specific analytical methods are presented as follows.

Page

WATER

GENERAL ANALYTICAL METHODS 127
TRACE METALS 130
OTHER REFERENCE METHODS FOR METALS 131
NUTRIENTS, ANIONS, AND ORGANICS. .133
OTHER PARAMETERS 139

AMBIENT AIR 139

SOURCE AIR 141

BIOLOGY 142

RADIATION 145

APPENDIX G (continued)

WATER

GENERAL ANALYTICAL METHODS

	Skill Rating No.
1. Alkalinity	
(a) Electrometric Titration, Manual: pH meter, Type I or II as defined in ASTM D1293	1
(b) Electrometric Titration, Automated: An automatic titrimeter meeting the pH meter specifications in (a)	1
(c) Automated, Methyl Orange: AutoAnalyzer with appropriate analytical manifold and 550-nm filters	2, 3
2. Biochemical Oxygen Demand (BOD), 5-day, 20°C	
(a) Modified Winkler with Full-Bottle: BOD incubation bottles; BOD incubator	2, 3
(b) Probe Method: No specific probe is recommended as superior in the 1974 EPA Methods Manual	2, 3
3. Chemical Oxygen Demand (COD)	
Reflux Apparatus	2, 3
4. Residue, Total	
Gravimetric, dried at 103-105°C: Blender (if samples contain oil or grease); Porcelain, vycor, or platinum evaporating dishes; Muffle furnace, 550°C; Steam bath or 98°C oven; Drying oven, 103-105°C; Dessicators; Analytical balance, 200-g capacity, weighting to 0.1 mg	1, 2
5. Residue, Total Filterable	
Glass Fiber Filtration, dried at 180°C: Glass fiber filter discs (0.45-um glass fiber filter); Filter holder, membrane filter funnel, or Gooch crucibles and adapter; Suction flask; Porcelain, vycor, or platinum evaporating dishes; Muffle furnace, 550°C; Steam bath; Drying oven, 180°C; Dessicators; Analytical balance, 200-g capacity, weighting to 0.1 mg	1, 2

Skill
Rating No.

WATER (Continued)

6. Residue, Total Non-Filterable

Glass Fiber Filtration, Dried at 103-105°C: Same as (5), except drying oven is at 103-105°C and steam bath, muffle furnace, and evaporating dishes are not required............................. 1, 2

7. Residue, Total Volatile

Gravimetric, Dried at 550°C: Same as (5)........................ 1, 2

8. Ammonia (as N)

(a) Distillation and Titration: All glass distillation apparatus (Kjeldahl); Standard titration apparatus........... 2, 3

(b) Distillation and Nesslerization: All-glass distillation apparatus (Kjeldahl); Nessler tubes, 50 ml, matched set, APHA standard; Spectrophotometer or filter photometer for use at 425 nm with light path $\geq$ 1 cm........................ 2, 3

(c) Distillation and Ammonia Electrode: All-glass distillation apparatus (Kjeldahl); Electrometer (pH meter) with expanded mV scale or specific ion meter; Ammonia-selective electrode; Magnetic stirrer, thermally-insulated, and Teflon-coated stirring bar.. 2, 3

(d) Automated Colorimetric Phenate Method: AutoAnalyzer with appropriate analytical manifold and 630-660 nm filter........ 2, 3

9. Total Kjeldahl Nitrogen (as N)

(a) Digestion, Distillation, and Titration: Same as 8(a) with suction takeoff to remove SO_3 fumes during digestion......... 2, 3

(b) Digestion, Distillation, and Nesslerization: Same as 8(b) with suction takeoff to remove SO_3 during digestion.......... 2, 3

(c) Digestion, Distillation, and Ammonia Electrode: Same as 8(c) with suction takeoff to remove SO_3 fumes during digestion.. 2, 3

(d) Automated Phenate Method: AutoAnalyzer with appropriate analytical manifold and 630-nm filter....................... 2, 3

Skill
Rating No.

WATER (Continued)

(e) Automated Selenium Method: AutoAnalyzer with appropriate analytical manifold and 630- or 650-nm filters............. 2, 3

10. Nitrate (as N)

(a) Cadmium Reduction Method (Nitrate-Nitrite): Glass fiber or membrane filters and associated apparatus; Copper/cadmium reduction column; Spectrophotometer or filter photometer for use at 540 nm with light path $\geq$ 1 cm........ 2, 3

(b) Automated Cadmium Reduction Method (Nitrate-Nitrite): Glass fiber or membrane filters and associated apparatus; Copper/cadmium reduction column; AutoAnalyzer with appropriate analytical manifold and 540-nm filter.......... 2, 3

(c) Brucine Method: Spectrophotometer or filter photometer for use at 410 nm; Water bath at 100°C (Temperature control is critical: all sample tubes must be held at the same temperature, and temperature must not drop significantly when tubes are immersed in bath); Water bath at 10-15°C; Neoprene-coated wire rack for holding sample tubes in baths; Glass sample tubes (40-50 ml).............. 2, 3

11. Phosphorus, Total as Ortho (as P)

(a) Single Reagent (Ascorbic Acid Reduction Method): Spectrophotometer or filter photometer for use at 650 nm (less sensitive) or 880 nm; Acid-washed, detergent-free glassware; Hotplate or autoclave (for persulfate digestion).. 2, 3

(b) Automated Colorimetric Ascorbic Acid Reduction Method: Acid-washed, detergent-free glassware; Hotplate or autoclave (for persulfate digestion); AutoAnalyzer with appropriate analytical manifold and 650-660 nm or 880-nm filter.. 2, 3

12. Acidity

(a) Hydrogen Peroxide Digestion and Electrometric Titration: pH meter, Type I or II as defined in ASTM D1293............ 1, 2

(b) Hydrogen Peroxide Digestion and Phenolphthalein End-Point Titration: No special equipment other than standard laboratory glassware...................................... 1, 2

Skill Rating No.

WATER (Continued)

13. Organic Carbon, Total (TOC)

Combustion and infrared method (CO_2) or flame ionization method (CH_4); Blender; Apparatus for total and dissolved organic carbon... 2, 3

14. Hardness, Total

(a) EDTA Titration: No special equipment other than standard laboratory glassware....................................... 1

(b) Automated Colorimeter: AutoAnalyzer with appropriate analytical manifold and 520-nm filter...................... 2, 3

15. Nitrate (as N)

(a) Manual Colorimeter Diazotization: Spectrophotometer for use at 540 nm with cells $\geq$ 1 cm; Nessler tubes or volumetric flasks, 50 ml.................................. 2

(b) Automated Colorimetric Diazotization: Glass fiber or membrane filters and associated apparatus; AutoAnalyzer with appropriate analytical manifold and 540-nm filter..... 2, 3

TRACE METALS

EPA specifies atomic absorption as at least one of the reference methods for many metals. The required equipment in each case will include: (1) an atomic absorption spectrophotometer, (2) the hollow cathode (or electrode-less discharge) lamp for each metal, and (3) the fuels and other apparatus specified below. Design features of some common atomic absorption spectrophotometers (as of March 1979) are discussed in the EPA Handbook for Analytical Quality Control in Water and Wastewater Laboratories. If extraction procedures are to be used, special reagents are required, but no special equipment other than standard laboratory glassware.

16. Metal by Atomic Absorption.................................... 2, 3

APPENDIX G (continued)

Skill
Rating No.

WATER (Continued)

OTHER REFERENCE METHODS FOR METALS

17. Aluminum

Eriochrome Cyanine R Colorimetric Method: Spectrophotometer for use at 535 nm, *or* Filter photometer with 525-535 nm filters (green), *or* Nessler tubes, 50 ml........................ 2, 3

18. Arsenic

Gaseous Hydride--Silver Diethyldithiocarbamate Colorimetric Method: Arsine generator and absorption tube; Spectrophotometer for use at 535 nm, *or* Filter photometer with 530-540 nm filter (green).. 2, 3

19. Beryllium

Aluminon Method: Spectrophotometer or filter photometer for use at 515 nm with 5-cm cells.................................. 2, 3

20. Boron

Curcumin Method: Spectrophotometer or filter photometer for use at 540 nm with cells ≥ 1 cm; Vycor or platinum evaporating dishes, 100-150 ml; Water bath, 55 ± 2°C; Ion exchange column, 50 cm x 1.3 cm (diameter)...................................... 2, 3

21. Cadmium

Dithizone Colorimetric Method: Spectrophotometer or filter photometer for use at 515 nm.................................. 2, 3

22. Calcium

EDTA Titration: No special equipment......................... 1

23. Chromium VI

Diphenylcarbazide Colorimetric: Membrane or sintered glass filter; Spectrophotometer or filter photometer for use at 540 nm with cells ≥ 1 cm...................................... 2, 3

APPENDIX G (continued)

Skill
Rating No.

WATER (Continued)

24. Chromium, Total

Oxidation and Diphenylcarbazide Colorimetric: Membrane or sintered glass filter; Spectrophotometer or filter photometer for use at 540 nm with cells ≥ 1 cm.................. 2, 3

25. Copper

Neocuproine Colorimetric: Spectrophotometer for use at 457 nm with cells ≥ 1 cm, or filter photometer with narrow-band violet filter (max. transmittance at 450-460 nm) and cells ≥ 1 cm, or Nessler tubes, 50 ml................................ 2, 3

26. Iron

O-Phenanthroline Colorimetric: Spectrophotometer or filter photometer for use at 510 nm with cells ≥ 1 cm, or Nessler tubes, 100 ml.. 2, 3

27. Lead

Dithizone Colorimetric: Spectrophotometer or filter photometer for use at 520 nm with cells ≥ 1 cm; pH meter................... 2, 3

28. Magnesium

Gravimetric: No special equipment............................. 2

29. Mercury

Manual Cold Vapor Technique (Water or Sediment): Commercially available mercury analyzer employing this technique, or atomic absorption spectrophotometer with open sample presentation area for mounting 10-cm absorption cell; Mercury hollow cathode lamp; Recorder, multi-range, variable speed, compatible with UV detection system; Absorption cell, 10 cm, quartz end windows, vapor inlet and outlet ports; Air pump, peristaltic, 1 liter/minimum; Flowmeter; Aeration tubing and drying tube (or incandescent lamp to warm cell); Autoclave (optional, for digestion procedure).. 2, 3

30. Nickel

Heptoxime Colorimetric Method: Spectrophotometer or filter photometer for use at 445 nm with cells ≥ 1 cm.................. 2, 3

Skill
Rating No.

WATER (Continued)

31. Potassium

(a) Colorimetric: Spectrophotometer for use at 425 nm with cells $\geq$ 1 cm, or Filter photometer with violet filter (maximum transmittance near 425 mm) and $\geq$ 1 cm cells, or Nessler tubes, 100 ml; Centrifuge and 25-ml centrifuge tubes...2, 3

(b) Flame Photometric: Flame photometer, direct-reading or internal-standard, and associated equipment for measurement at 768 nm.. 2, 3

32. Sodium

Flame Photometric: Flame photometer, direct-reading or internal-standard, and associated equipment for measurement at 589 nm; For low-solids water, air filter and blower for burner housing, oxyhydrogen flame, and polyethylene or Teflon cups, bottles, etc...................................... 2, 3

33. Vanadium

Colorimetric (Catalysis of Gallic Acid Oxidation): Spectrophotometer or filter photometer for use at 415 nm with 1-5 cm cells; Water bath, 25 ± 0.5°C................................. 2, 3

34. Zinc

Dithizone Colorimetric Method: Spectrophotometer or filter photometer for use at 535 or 620 nm with 2-cm cells, or Nessler tubes, matched; pH meter............................... 2, 3

NUTRIENTS, ANIONS, AND ORGANICS

35. Organic Nitrogen (as N)

Kjeldahl Nitrogen Minus Ammonia Nitrogen: See (8) and (9) above.. 2, 3

36. Sulfate (as SO_4)

(a) Gravimetric: Analytical balance, weighing to 0.1 mg; Steam bath; Drying oven, 180°C; Muffle furnace, 800°C; Appropriate filters or crucibles.......................... 2

	Skill Rating No.
WATER (Continued)	
(b) Turbidimetric: Nephelometer, or Spectrophotometer or filter photometer for use at 420 nm with 4-5 cm cells; Magnetic stirrer with timer or stopwatch	2
(c) Automated Colorimetric Barium Chloroanilate: AutoAnalyzer with appropriate analytical manifold and 520-nm filter; Magnetic stirrer	2, 3
37. Sulfide (as S)	
Titrimetric Iodine: No special equipment other than standard laboratory glassware	2
38. Sulfite (as SO_3)	
Titrimetric Iodide-Iodate: No special equipment other than standard laboratory glassware	2
39. Bromide	
Titrimetric Iodide-Iodate: No special equipment other than standard laboratory glassware	2
40. Chloride	
(a) Silver Nitrate: No special equipment other than standard laboratory glassware	1
(b) Mercuric Nitrate: No special equipment other than standard laboratory glassware	1
(c) Automated Colorimetric Ferricyanide: AutoAnalyzer with appropriate analytical manifold and 480-nm filter	2, 3
41. Cyanide, Total	
(a) Distillation and Silver Nitrate Titration: Cyanide distillation apparatus; Koch microburet, 5 ml	2, 3
(b) Distillation and Pyridine-Pyrazolone (or Pyridine-Barbituric Acid) Colorimetric: Cyanide distillation apparatus; Spectrophotometer or filter photometer for use at 578 or 620 nm with $\geq$ 1-cm cells	2, 3

Skill
Rating No.

WATER (Continued)

42. Fluoride

(a) Distillation--SPADNS: Bellack distillation apparatus; Spectrophotometer for use at 570 nm with ≥ 1-cm cells, or Filter photometer with green-yellow filter (max. transmittance 550-580 nm) and ≥ 1-cm cells................. 2, 3

(b) Automated Complexone Method: AutoAnalyzer with appropriate analytical manifold and 650-nm filter.......... 2, 3

(c) Fluoride Electrode: Electrometer; Fluoride ion activity electrode; Reference electrode, single junction, sleeve-type; Magnetic mixer....................................... 2

43. Chlorine, Total Residual

(a) Starch-Iodide Titration: No special equipment other than standard laboratory glassware............................. 2

(b) Amperometric Titration: Amperometric end-point detection apparatus consisting of noble metal electrode, salt bridge, and silver-silver chloride reference electrode cell unit connected to microammeter with appropriate electrical accessories; Agitator...................................... 2

44. Oil and Grease

(a) Gravimetric: Separatory funnels or soxhlet apparatus; Vacuum.. 2, 3

(b) Infrared: Separatory funnels; Infrared spectrophotometer, double beam, with 1-, 5-, and 10-cm cells................. 2, 3

45. Phenols

(a) Colorimetric (4-AAP Method with Distillation): Phenols distillation apparatus; Spectrophotometer or filter photometer for use at 460 nm (following chloroform extraction) or 510 nm and 1- to 10-cm cells; pH meter...... 2, 3

(b) Automated 4-AAP Method: AutoAnalyzer with appropriate analytical manifold and 505- or 520-nm filter............... 2, 3

Skill Rating No.

WATER (Continued)

46. Surfactants

Methylene Blue Colorimetric: Spectrophotometer or filter photometer for use at 625 nm with $\geq$ 1-cm cells.................. 2

47. Algicides

Gas Chromatography: There is no reference procedure for algicides as a class, and, therefore, detailed equipment requirements cannot be specified. For general discussions of gas chromatography and its application in environmental monitoring, see the EPA Training Manual for Pesticide Residue Analysis in Water and the EPA Methods Manual for Analysis of Pesticide Residues in Human and Environmental Samples........... 3, 4

48. Benzidine

Diazotization and Colorimetric: Spectrophotometer, scanning, 510-370 nm; Cells, 1- to 5-cm pathlength, 20-ml max. volume......... 3

49. Chlorinated Organic Compounds (Except Pesticides)

Gas Chromatography: There is no reference procedure for chlorinated organic compounds as a class, and, therefore, detailed equipment requirements cannot be specified. Gas chromatography with electron capture, microcoulometry, or electrolytic conductivity detection may be appropriate for individual compounds or groups of compounds. For general discussions of gas chromatography and its application in environmental monitoring, see the EPA Training Manual for Pesticide Residue Analysis in Water and the EPA Methods Manual for Analysis of Pesticide Residues in Human Environmental Samples.. 3, 4

50. Pesticides

There is no single reference procedure for pesticides as a class. However, specific reference procedures for several sub-classes are available from EMSL, U.S. EPA, Cincinnati, Ohio. To be qualified in this parameter, the laboratory should be equipped to analyze for all specified sub-classes. The analysis of pesticides at the levels normally found in wastewater and other environmental sources requires special expertise and experience, in addition to up-to-date, well-maintained,

Skill
Rating No.

WATER (Continued)

calibrated instrumentation and apparatus. The equipment lists below are based on the EMSL methods; for further information on the equipment and methodology of pesticide analysis, see the EPA Training Manual for Pesticide Residue Analysis in Water and the EPA Methods Manual for Analysis of Pesticide Residues in Human and Environmental Samples

(a) Organochlorine Pesticides: Gas chromatograph with (1) Glass-lined injection port, (2) One or more of the following detectors: electron capture, radioactive (H^3 or Ni^{63}), microcoulometric titration; electrolytic conductivity, (3) Recorder, potentiometric, 10" strip chart, and (4) Appropriate Pyrex gas chromatographic columns; Snyder columns, 3-ball (macro) and 2-ball (micro), and other K-D glassware; Appropriate columns for liquid-solid partition chromatography; Blender; and Special materials, such as PR Grade Florisil and pesticide standards.............. 3, 4

(b) Organophosphorus Pesticides: Gas chromatograph with (1) Glass-lined injection port, (2) One or more of the following detectors: flame photometric, 526-nm phosphorus filter; electron capture, radioactive (H^3 or Ni^{63}), (3) Recorder, potentiometric, 10" strip chart, and (4) Appropriate Pyrex gas chromatographic columns; Snyder columns, 3-ball (macro) and 2-ball (micro), and Other K-D glassware; Appropriate columns for liquid-solid partition chromatography; Blender; Special materials, such as PR Grand Florisil Woelm neutral alumina, and pesticide standards............ 3, 4

(c) Polychlorinated Biphenyls (PCBs): Gas chromatograph with (1) Glass-lined injection port, (2) One or more of the following detectors: electron capture, radioactive (H^3 or Ni^{63}), microcoulometric titration, electrolytic conductivity, (3) Recorder, potentiometric, 10" strip chart, and (4) Appropriate Pyrex gas chromatographic columns; Snyder column, 3-ball (macro); Appropriate columns for liquid-solid partition chromatography; Low-pressure regulator (0-5 psig) with low-flow needle valve; Blender; Special materials, such as PR Grade Florisil, high-quality silica gel, and Aroclor (PCB) standards........... 3, 4

Skill
Rating No.

WATER (Continued)

(d) Triazine Pesticides: Gas chromatograph with (1) Glass-lined injection port, (2) Electrolytic conductivity detector, (3) Recorder, potentiometric, 10" strip chart, and (4) Appropriate Pyrex gas chromatographic column; Snyder columns, 3-ball (macro) and 2-ball (micro), and Other K-D glassware; Appropriate columns for liquid-solid partition chromatography; Blender; Special material, such as PR Grade Florisil and pesticide standards.................................... 3, 4

(e) O-Aryl Carbamate Pesticides: Thin layer chromatography plates, 200 x 200 mm, coated with Silica Gel G, 0.25 mm; Associated TLC apparatus, including spotting template, developing chamber, and sprayer (20 ml).................... 3, 4

51. Organics

Gas chromatography/mass spectrometry........................... 4

52. Organics

High-pressure liquid chromatography............................ 4

53. Specific Conductance (mho/cm @ 25°C)

Wheatstone bridge: Commercial conductivity meter, or apparatus consisting of (1) Wheatstone bridge (reading to 1% accuracy or better), (2) Appropriate source of electrical current, (3) Specific conductance cell, (4) Water bath, 25°C, with racks... 1

54. Turbidity (Jackson Units)

Turbidimeter Method: Nephelometric turbidimeter................ 1

55. Streptococci Bacteria, Fecal (Number/100 ml)

(a) Membrane Filter: Autoclave (to 121°C); Filter membranes; Petri culture dishes; Incubator, 35 ± 0.5°C, ca. 90% relative humidity; Low-power (10-15X), binocular, wide-field, dissecting microscope and light source......... 2, 3

(b) MPN: Autoclave (to 121°C); Inoculation tubes; Incubator, 35 ± 0.5°C... 2, 3

Skill Rating No.

WATER (Continued)

(c) Plate Count: Autoclave (to 121°C); Petri culture dishes; Incubator, 35 ± 0.5°C; Microscope and light source, or colony counter; Petri culture dishes; incubator, 35 ± 0.5°C; Microscope and light source, or colony counter.. 2, 3

56. Coliform Bacteria, Fecal (Number/100 ml)

(a) MPN: Autoclave (to 121°C); Inoculation tubes; Incubator, 35 ± 0.5°C; Water bath, 44.5 ± 0.2°C........................ 2, 3

(b) Membrane Filter: Autoclave (to 121°C); Filter membranes; Petri culture dishes; Water bath, 44.5 ± 0.2°C; Low-power (10-15X), binocular, wide-field, dissecting microscope and light source.. 2, 3

57. Coliform Bacteria, Total (Number/100 ml)

(a) MPN: Same as 56 (a)...................................... 2, 3

(b) Membrane Filter: Same as 56 (b).......................... 2, 3

OTHER PARAMETERS

58. Temperature: Good quality mercury-filled or dial-type centrigrade thermometer, or a thermistor........................ 1

59. pH: pH meter (electrometer using either glass electrode and reference, such as saturated calomel, or a combination glass and reference electrode)... 1

AMBIENT AIR

60. Sulfur Dioxide (ug/m^3 or ppm)

(a) Pararosaniline Method: Absorber; Pump; Air flowmeter or critical orifice; Spectrophotometer for use at 548 nm, band width < 15 nm, with 1-cm cells....................... 2, 3

(b) Automated Pararosaniline: Autoanalyzer with appropriate manifold and 548-nm filter................................ 2, 3

(c) Continuous Analyzer: EPA-designated equivalent method instrumentation... 2, 3

Skill
Rating No.

AMBIENT AIR (continued)

61. Suspended Particulates (ug/m^3)

(a) High-Volume Sampler: High-volume sampler; Shelter for sampler; Flow measurement equipment, including (1) Rotameter, (2) Orifice calibration unit, (3) Differential manometer, (4) Positive displacement meter; Barometer; Environment for conditioning filters; Analytical balance: chamber to hold unfolded 8" x 10" filters, sensitivity = 0.1 mg; Glass fiber filters; Acceptable alternative equipment for flow measurement (3-6): Exhaust orifice meter, interfaced with a circular chart recorder........... 1, 2

(b) Continuous High-Volume: EPA-designated equivalent instrumentation.. 2, 3

62. Carbon Monoxide (ug/m^3 or ppm)

Non-Dispersive Infrared Spectrometry: Carbon monoxide analyzer; Pump, flow control valve, and flowmeter; In-line filter for particles (2-10 um); Moisture control (refrigeration unit or drying tube)................................... 2, 3

63. Photochemical Oxidant (O_3) (ug/m^3 or ppm)

Chemiluminescence, Continuous: Commercial photochemical oxidant (O_3) analyzer, or apparatus consisting of (1) Detector cell, (2) Flowmeters (air and ethylene), (3) Air inlet filter (Teflon, 5 m), (4) Photomultiplier tube, (5) High voltage power supply, (6) Direct current amplifier, (7) Recorder, (8) Ozone source (low pressure Hg lamp/quartz tube) and dilution system; Apparatus for calibration (KI -> I_2 Spectrophotometric Method)....................... 2, 3

64. Total Hydrocarbons (Corrected for Methane) GC - FID

Method: Commercially-available THC, CH_4, and CO Analyzer; Pump, flow control valves, automatic switching valves, and flowmeter; In-line filter (3-5 um); Stripper or precolumn; Oven (for column and catalytic converter)...................... 2, 3

AMBIENT AIR (continued)	Skill Rating No.
65. Nitrogen Dioxide (ug/m^3 or ppm)	
(a) Arsenite 24-Hour Sampling Method: Sampling train (bubbler, trap, membrane filter, 27-gauge hypodermic needle, air pump, calibration equipment); Standard glassware (volumetrics, pipets, graduated cylinders, etc.); Spectrophotometer or colorimeter for use at 540 nm	2, 3
(b) Continuous Chemiluminescent Method: Commercial chemiluminescent analyzer [generally including particulate filter, thermal converter, (NO_2---NO), ozone generator, reaction chamber, optical filter, photomultiplier tube, and vacuum pump; instrument will be specified as EPA equivalent method]; Calibration apparatus (Gas-Phase Titration Method) [generally including air flow controller, air flowmeters, pressure regulator for NO cylinder, NO flowmeters, capillary restriction, ozone generator, reaction chamber and mixing bulb, sample manifold, NO detector, iodometric calibration apparatus]	2, 3
(c) Griess-Saltzman Colorimetric, Continuous: Sampling train; Colorimeter for use at 550 nm	2, 3
SOURCE AIR	
66. Stack Gas Velocity (EPA Method 2): Pitot tube	2
67. Dry Molecular Weight of Gas (EPA Method 3)	
(a) Orsat	2
(b) Gas chromatograph with thermal conductivity detector	2
68. Stack Gas Moisture (EPA Method 4): Midget impingers; Sample metering pump	2
69. Particulates (EPA Method 5): Heated filter holder; Impingers; Sample metering pump; Analytical balance; Heated probe	2, 3
70. Sulfur Dioxide (EPA Method 6): Impingers; Sample metering pump; Burettes	2, 3

APPENDIX G (continued)

	Skill Rating No.
SOURCE AIR (Continued)	
71. Nitrogen Oxide (EPA Method 7): Round-bottom flasks; Vacuum pump; Hot plate; Spectrophotometer	2, 3
72. Sulfuric Acid Mist (EPA Method 8): Source sampling train; Burettes	2, 3
73. Visible Emissions (EPA Method 9): Stopwatch	2
74. Carbon Monoxide (EPA Method 10): Non-dispersive infrared analyzer	2, 3
75. Hydrogen Sulfide (EPA Method 11): Same as 70	2, 3
76. Fluoride	
(a) EPA Method 13A: Spectrophotometer	2, 3
(b) EPA Method 13B: Fluoride-specific ion electrodes; Specific ion meter	2, 3
77. Sulfur Compounds (EPA Method 15): Gas chromatograph with flame photometric detector; All Teflon dilution system; Mass flowmeter; Heated sampling line; Permeation system	3, 4
78. Sulfur Compounds (EPA Method 16): Two gas chromatographs with flame photometric detectors; All Teflon dilution system; Mass flowmeter; Heated sampling line; Permeation system	3, 4
79. Particulates (EPA Method 17): In-stack filter holder; Impingers; Sample metering pump; Analytical balance	2, 3
BIOLOGY	
80. Wildlife and Terrestrial Methods	
(a) Cover and Habitat Assessment: Ocular instrumentation	3, 4
(b) Mapping and Vegetation Analysis: Planimeter; Statistical instrumentation	2, 3, 4
(c) Photo Interpretation: Stereoscope	3, 4
(d) Biomass Determination: General laboratory instrumentation	1, 2, 3

APPENDIX G (continued)

		Skill Rating No.
BIOLOGY (Continued)		
(e)	Species Composition/Density: Statistical instrumentation	2, 3, 4
(f)	Ecosystem Analysis: Statistical instrumentation; Graphical instrumentation	3, 4
(g)	Community Analysis: Same as (f)	3, 4
(h)	Systems Analysis: Computer	4
(i)	Inventory of Mammals: Ocular instrumentation; Mechanical traps	1,2,3,4
(j)	Inventory of Birds: Same as (i)	2, 3, 4
(k)	Inventory of Reptiles and Amphibians: Same as (i)	2, 3, 4
(l)	Inventory of Terrestrial Insects: Same as (i)	2, 3, 4
81.	Bioassay	
(a)	Culture Maintenance: General laboratory equipment	2
(b)	Routine Static Assays: General laboratory equipment	2
(c)	Chronic Assays: Proportional diluters; Metering pumps; Photometers	3
(d)	Non-Routine Assays: Dependent on type of assay	3, 4
(e)	Physiological/Biochemical: Multi-channel recorder; Photometer	3, 4
82.	Fish: Age and Growth	
(a)	Collection: Electrofisher; Nets; Seines; Trawls; Traps; Toxicants	1, 2
(b)	Scale Analysis: Scale press; Scale reader	2
83.	Fish: Population Dynamics	
(a)	Collection: Same as 82(a)	1, 2

APPENDIX G (continued)

BIOLOGY (Continued)

	Skill Rating No.
(b) Mark and Recapture Methods: Method-specific materials	1, 2, 3
(c) Predictive Models: Statistical instrumentation	3, 4
84. Fish: Feeding Habits	
(a) Collection: Same as 73(a)	1, 2
(b) Stomach Content Analysis	2, 3
85. Phytoplankton	
(a) Collection: Plankton net	1, 2, 3
(b) Analysis: Microscope with Sedwick-Rafter Cell	3, 4
86. Zooplankton	
(a) Collection: Zooplankton net	1, 2, 3
(b) Microscope	
87. Periphyton	
(a) Collection: Glass slides attached to floats or other sampling apparatus	1, 2, 3
(b) Analysis: Microscope	3, 4
88. Aquatic and Terrestrial	
(a) Specific Macrophyte Collection: Macrophyte standard sampler	2, 3
(b) Macrophyte Taxonomy: Ocular instrumentation	2, 3, 4
89. Chlorophyll	
(a) Spectrophotometric: Variable wavelength spectrophotometer	2, 3
(b) Fluorometric: Fluorometer	2, 3

RADIATION

The analysis of radiological parameters requires special expertise and experience, in addition to up-to-date, well-maintained, calibrated instrumentation and apparatus.

	Skill Rating No.
90. Alpha, Total (pCi/liter): Windowless Gas-Flow Proportional Counter and associated equipment, or Thin Window Gas-Flow Proportional Counter and associated equipment, or Alpha Scintillation Counter and associated equipment, or Alpha Spectrometer System (Surface Barrier Type) and associated equipment	2, 3, 4
91. Alpha Counting Error (pCi/liter): Same as 90	2, 3, 4
92. Beta, Total (pCi/liter): Windowless Gas-Flow Proportional Counter and associated equipment, or Thin Window Gas-Flow Proportional Counter and associated equipment, or Beta Scintillation Counter and associated equipment, or Liquid Scintillation Counter and associated equipment	2, 3, 4
93. Beta Counting Error (pCi/liter): Same as 92	2, 3, 4
94. Radium, Total (pCi/liter): Windowless gas-flow proportional counter and associated equipment, or Thin window gas-flow proportional counter and associated equipment, or Alpha scintillation counter and associated equipment, or Alpha spectrometer (surface barrier type) system and associated equipment, or Radon gas counting system and associated equipment	2, 3, 4

APPENDIX H

SAMPLE PRESERVATION METHODS AND RECOMMENDED HOLDING TIMES

TABLE H-1. WATER PARAMETERS(1,2)

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(7)
Acidity	100	P, G(3)	Cool, 4°C	24 Hours
Alkalinity	100	P, G	Cool, 4°C	24 Hours
Arsenic	100	P, G	HNO_3 to pH<2	6 Months
Biological Oxygen Demand (BOD)	1,000	P, G	Cool, 4°C	6 Hours(4)
Bromide	100	P, G	Cool, 4°C	24 Hours
Chemical Oxygen Demand (COD)	50	P, G	H_2SO_4 to pH<2	7 Days
Chloride	50	P, G	None Req.	7 Days
Chlorine Req.	50	P, G	Cool, 4°C	24 Hours
Color	50	P, G	Cool, 4°C	24 Hours
Cyanides	500	P, G	Cool, 4°C NaOH to pH 12	24 Hours
Dissolved Oxygen				
Probe	300	G only	Det. on site	No Holding
Winkler	300	G only	Fix on site	No Holding
Fluoride	300	P, G	Cool, 4°C	7 Days
Hardness	100	P, G	Cool, 4°C	7 Days
Iodide	100	P, G	Cool, 4°C	24 Hours
MBAS	250	P, G	Cool, 4°C	24 Hours
Metals				
Dissolved	200	P, G	Filter on site HNO_3 to pH<2	6 Months
Suspended			Filter on site	6 Months
Total	100		HNO_3 to pH<2	6 Months
Mercury				
Dissolved	100	P, G	Filter HNO_3 to pH<2	38 Days (Glass) 13 Days (Hard Plastic)

(continued)

TABLE H-1 (continued)

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(7)
Total	100	P, G	HNO_3 to pH<2	38 Days (Glass) 13 Days (Hard Plastic)
Nitrogen				
Ammonia	400	P, G	Cool, 4°C H_2SO_4 to pH<2	24 Hours(5)
Kjeldahl	500	P, G	Cool, 4°C H_2SO_4 to pH<2	24 Hours(5)
Nitrate	100	P, G	Cool, 4°C H_2SO_4 to pH<2	24 Hours(5)
Nitrite	50	P, G	Cool, 4°C	24 Hours(5)
NTA	50	P, G	Cool, 4°C	24 Hours
Oil & Grease	1,000	G only	Cool, 4°C H_2SO_4 to pH<2	24 Hours
Organic Carbon	25	P, G	Cool, 4°C H_2SO_4 to pH<2	24 Hours
pH	25	P, G	Cool, 4°C Det. on site	6 Hours(4)
Phenolics	500	G only	Cool, 4°C H_3PO_4 to pH<4 1.0 g $CuSO_4$/l	24 Hours
Phosphorus				
Orthophosphate, Dissolved	50	P, G	Filter on site Cool, 4°C	24 Hours(5)
Hydrolyzable	50	P, G	Cool, 4°C H_2SO_4 to pH<2	24 Hours(5)
Total	50	P, G	Cool, 4°C	24 Hours(5)
Total, Dissolved	50	P, G	Filter on site Cool, 4°C	24 Hours(5)
Residue				
Filterable	100	P, G	Cool, 4°C	7 Days
Non-Filterable	100	P, G	Cool, 4°C	7 Days
Total	100	P, G	Cool, 4°C	7 Days
Volatile	100	P, G	Cool, 4°C	7 Days
Settleable Matter	1,000	P, G	None Req.	24 Hours
Selenium	50	P, G	HNO_3 to pH<2	6 Months
Silica	50	P only	Cool, 4°C	7 Days
Specific Conductance	100	P, G	Cool, 4°C	24 Hours(6)

(continued)

TABLE H-1 (continued)

Measurement	Vol. Req. (ml)	Container	Preservative	Holding Time(7)
Sulfate	50	P, G	Cool, 4°C	7 Days
Sulfide	50	P, G	2 ml zinc acetate	24 Hours
Sulfite	50	P, G	Cool, 4°C	24 Hours
Temperature	1,000	P, G	Det. on site	No Holding
Threshold Odor	200	G only	Cool, 4°C	24 Hours
Turbidity	100	P, G	Cool, 4°C	7 Days

1. More specific instructions for preservation and sampling are found with each procedure as detailed in this manual. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 31, p. 68-78 (1978).

2. U.S. Environmental Protection Agency Office of Research and Development. Environmental Monitoring and Support Laboratory. 1979. Methods for Chemical Analyses of Water and Wastes. Cincinnati, Ohio. EPA-625/6-74-003.

3. Plastic or Glass.

4. If samples cannot be returned to the laboratory in less than 6 hours and holding time exceeds this limit, the final reported data should indicate the actual holding time.

5. Mercuric chloride may be used as an alternate preservative at a concentration of 40 mg/l, especially if a longer holding time is required. However, the use of mercuric chloride is discouraged whenever possible.

6. If the sample is stabilized by cooling, it should be warmed to 25°C for reading, or temperature correction should be made and results reported at 25°C.

7. It has been shown that samples properly preserved may be held for extended periods beyond the recommended holding time.

TABLE H-2. AMBIENT AIR SAMPLES

Parameter	Recommended holding time	Preservation method
Particulate Filters	Indefinite	Store in controlled atmosphere of <50% relative humidity
Sulfur Dioxide (Pararosaniline Method)	30 days, if properly stored	Store at <4°C after collection, during transport, and before analysis
Nitrogen Oxides (Sodium-Arsenite Method)	6 weeks	Samples are stable for 6 weeks at room temperature
Fluoride	None	Collect and store in plastic containers

APPENDIX I

QUALITY ASSURANCE AUDIT CHECKLIST

This form has been prepared to be used in the on-site audit of projects. Personnel performing the audit should list any questions which were not clear from the information provided by the Quality Assurance Pre-Audit worksheet in this checklist and obtain answers during the actual site visit.

This form is to be used in the actual performance of an on-site project audit.

This checklist is to be completed by the personnel involved in the on-site audit.

APPENDIX I (Continued)

QUALITY ASSURANCE AUDIT CHECKLIST

Laboratory: ____________________

Street Address: ____________________

Mailing Address (If Different): ____________________

City ____________ State ____________ Zip ____________

Laboratory Telephone No.: Area Code ________ No. ____________

Laboratory Director: ____________________

Quality Assurance Supervisor: ____________________

Personnel Contacted During Audit:

Name	Title

Contract Number: ____________________

Contract Title: ____________________

Project Officer: ____________________

Audit Conducted By: ____________________

Agency and Address: ____________________
____
____

Telephone No.: Area Code ________ No. ____________

Date Audit Performed: ____________________

APPENDIX I (continued)

A. ORGANIZATION AND PERSONNEL

A.1. Review the Pre-Audit Worksheet and list questions from the Organization and Personnel section of the Pre-Audit Worksheet to be discussed during the QA audit.

Q1.

A1.

Q2.

A2.

Q3.

A3.

Q4.

A4.

Q5.

A5.

A.2. Organization and Personnel Checklist

	Yes	No	Comment
Do personnel assigned to this project have the appropriate educational background to successfully accomplish the objectives of the program?			
Do personnel assigned to this project have the appropriate level and type of experience to successfully accomplish the objectives of this program?			
Is project organization appropriate to accomplish the objectives of this program?			
Is the project adequately staffed to meet project commitments in a timely manner?			
Are project reporting relationships clear?			
If any special training or experience is required, is it represented on the project staff?			
Does the laboratory have a Quality Assurance Supervisor who reports to senior management levels?			
Was the Project Manager available during the QA audit?			
Was the Quality Assurance Supervisor available during the QA audit?			
Does the project schedule show adequate time to accomplish the sampling program and does it allow for uncontrollable delays, such as bad weather?			
Does the project schedule allow sufficient time between sample collection and reporting of the data to apply adequate analytical quality control, including supervisory review of the data?			

A.3. Does the project organization plan and schedule give adequate attention and time to the sampling and analysis effort? ________

Comments on project organization and schedule:

A.4. Are the personnel assigned to this project generally qualified to accomplish the objectives of the program? ________

Comments on personnel:

B. FACILITIES

When touring the facilities, give special attention to: (a) the overall appearance of organization and neatness, (b) the proper maintenance of facilities and instrumentation, (c) the general adequacy of the facilities to accomplish the required work, and (d) sampling equipment required for the project.

B.1. General Facilities Checklist

	Yes	No	Comment
Does the laboratory appear to have adequate workspace (120 sq. feet, 6 linear feet of unencumbered bench space per analyst)?			
Are voltage control devices used on major instrumentation (e.g., GC/MS, spectrophotometers)?			
Does the laboratory have a source of distilled/demineralized water?			
Is the conductivity of distilled/demineralized water routinely checked and recorded?			
Is the analytical balance located away from draft and areas subject to rapid temperature changes?			
Has the balance been calibrated within one year?			
Are exhaust hoods provided to allow organized work with volatile materials?			
Is the laboratory maintained in a clean and organized manner?			
Are safe and contamination-free work areas provided for the handling of toxic or radioactive materials?			
Are the radioactive and/or toxic chemical handling areas either a stainless steel bench or an impervious material covered with absorbent material?			

APPENDIX I (continued)

	Yes	No	Comment
Are adequate facilities provided for storage of samples, including cold storage?			
Are chemical waste disposal facilities adequate?			
Are contamination-free areas provided for trace level analytical work?			
Can the laboratory supervisor document that trace metals-free water is available for preparation of standards and blanks?			
Is organic-free water available for preparation of standards and blanks?			
If biotesting is to be conducted, are adequate environment-controlled facilities available (e.g., light, temperature control)?			
Is the required field instrumentation and sampling equipment properly maintained?			
Is adequate safety equipment (fire extinguishers, showers, eyewash stations) located throughout the laboratory?			
If bacteriological analyses are to be conducted, is an aseptic work area provided?			
Are bacteriological incubators maintained at the proper temperature (35 ± 0.5°C for total coliform and fecal streptococcus; 44.5 ± 0.2°C for fecal coliform)?			
Are boats, motors, vehicles, and other mobile facilities available as required?			

B.2. Instruments. List the major laboratory and *in situ* analytical instruments that will be used. Complete an instrument evaluation form on each one.

Instrument	Analysis

APPENDIX I (continued)

INSTRUMENT EVALUATION

Instrument: ______________________

Instrument Mfg. ______________________

Model: ______________________ Year of Acquisition: __________

Condition: ______________________

Calibration Frequency: ______________________

Service Maintenance Frequency: ______________________

Other Pertinent Information: ______________________

	yes	no
Are Manufacturer's operating manuals readily available to the operator?		
Is there a calibration protocol available to the operator?		
Are calibrations kept in a permanent record?		
Is a permanent service record maintained?		
Has the instrument been modified in any way?		

SATISFACTORY? ☐ ☐

Comments: ______________________

APPENDIX I (continued)

INSTRUMENT EVALUATION

Instrument: ____________________

Instrument Mfg. ____

Model: ____________________ Year of Acquisition: __________

Condition: ____

Calibration Frequency: ____

Service Maintenance Frequency: ____

Other Pertinent Information: ____

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	yes	no
Are Manufacturer's operating manuals readily available to the operator?		
Is there a calibration protocol available to the operator?		
Are calibrations kept in a permanent record?		
Is a permanent service record maintained?		
Has the instrument been modified in any way?		

SATISFACTORY? ☐ ☐

Comments: ____

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APPENDIX I (continued)

INSTRUMENT EVALUATION

Instrument: ____________________

Instrument Mfg. ____________________

Model: ____________________ **Year of Acquisition:** __________

Condition: ____________________

Calibration Frequency: ____________________

Service Maintenance Frequency: ____________________

Other Pertinent Information: ____________________

____

____

____

	yes	no
Are Manufacturer's operating manuals readily available to the operator?		
Is there a calibration protocol available to the operator?		
Are calibrations kept in a permanent record?		
Is a permanent service record maintained?		
Has the instrument been modified in any way?		

SATISFACTORY? ☐ ☐

Comments: ____________________

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C. ANALYTICAL METHODOLOGY

C.1. Review the Pre-Audit Worksheet and list items from the Analytical Methodology section of the Pre-Audit Worksheet to be discussed during the QA audit.

Q1.
A1.

Q2.
A2.

Q3.
A3.

Q4.
A4.

Q5.
A5.

APPENDIX I (continued)

C.2. Conduct discussions with two or more individuals who have analytical responsibilities in connection with the project. The following points should be addressed to determine each individual's awareness and application of QA/QC procedures:

1. Specific project responsibilities,
2. Level of knowledge of the analytical methods used,
3. Awareness of and adherence to the laboratory's QC procedures, and
4. Appearance and accuracy of the work records.

Analyst ____________________ ____________________
Name Responsibility

Comments:

Analyst ____________________ ____________________
Name Responsibility

Comments:

APPENDIX I (continued)

Analyst	Name	Responsibility

Comments:

Analyst	Name	Responsibility

Comments:

APPENDIX I (continued)

C.3. Analytical Methodology Checklist.

Item	Yes	No	Comment
Are standard methods (e.g., EPA, ASTM, Standard Methods for the Examination of Water and Wastewater) used when available?			
Have standard methods been altered in any way? If so, is it justified?			
Are written analytical procedures provided to the analyst?			
Are reagent grade or higher purity chemicals used to prepare standards?			
Are samples analyzed within the linear range of the method in all cases?			
Does the standard curve bracket the concentration of the samples on each sample run?			
Are fresh analytical standards prepared at the required frequency?			
Are standards run periodically during a long sample run?			
Are reference standards properly labeled with concentrations, date of preparation, and the identity of the person preparing the sample?			
Do the analysts record bench data in a neat and accurate manner?			
Is the appropriate instrumentation used in accordance with standard procedures?			
Are methods used which are appropriate to the sample matrix (e.g., saline waters, wastewaters)?			

APPENDIX I (continued)

Item	Yes	No	Comment
Are analytical detection limits adequate for the purposes of the project?			
Are the analytical procedures used adequately documented? For example, if a standard method is not available, is a written procedure incorporated into the project plan?			
Are all strip charts properly labeled with instrument conditions, date, and sample numbers?			
Are samples properly handled (e.g., organized, chilled as necessary, appropriate containers) before, during, and after analysis?			

C.4. Are the analytical methods used satisfactory to accomplish the objectives of the program? _________ Are laboratory practices acceptable? _________

Comments on analytical methods and practices:

D. SAMPLING AND SAMPLE HANDLING

D.1. Review the Pre-Audit Worksheet and list the items from the Sampling and Sample Handling section of the Pre-Audit Worksheet to be discussed.

Q1.

A1.

Q2.

A2.

Q3.

A3.

Q4.

A4.

Q5.

A5.

D.2. Conduct discussions with two or more individuals who have sampling responsibilities in connection with the project. The following points should be addressed to determine each individual's awareness and application of appropriate sampling procedures:

1. Specific project responsibility,
2. Level of knowledge of acceptable sampling procedures,
3. Adherence to the project sampling plan, and
4. Neatness and accuracy of field records.

Field Technician ____________________ ____________________
Name Responsibility

Comments:

Field Technician ____________________ ____________________
Name Responsibility

Comments:

APPENDIX I (continued)

D.3. Sampling Equipment and Procedures Checklist

Item	Yes	No	Comment
Are the sampling procedures specifically defined in the project QA plan or other referenced document?			
Is the sampling program well organized?			
Have appropriate techniques been used in selecting sampling sites?			
Are proper containers used for sample collection, transport, and storage?			
Are sample containers properly prepared before sample collection to avoid sample contamination? Containers for organics should be solvent rinsed; for trace metals, acid rinsed.			
Are the proper preservatives used in the samples for each parameter? (See Appendix H)			
Are permanent labels affixed to sample containers?			
Do the sample labels contain adequate information (date, time, sample location, samples) and a unique sample identification number?			
Are proper techniques used to collect representative samples while avoiding sample contamination?			
Are duplicate samples collected? What frequency?			
Are samples shipped promptly to the laboratory in order to meet recommended holding time deadlines? (See Appendix H)			
Are chain-of-custody records available for inspection? Are they neat and understandable? Have the required custody signatures been obtained?			

APPENDIX I (continued)

D.4. Field Notebooks. Review one or more field notebooks and determine if the following information is recorded.

Item	Yes	No	Comment
Is a permanent bound notebook used to record all field data and observations?			
Is the notebook reasonably neat and organized, considering the use under adverse field conditions?			
Are field instrument and in situ instrument calibration data recorded daily?			
Are sample location, time, and number accurately and completely recorded?			
Are in situ data neatly recorded in an understandable manner?			
Are ambient data (i.e., weather) recorded when appropriate?			
Are the necessary engineering data (e.g., flow, operating conditions) recorded?			
Have supervisory personnel reviewed the field notebook and so indicated by their signature?			

D.5. Is the sampling program adequate to accomplish the objectives of the project? ____________________

Comments on the sampling program and sample collection:

E. QUALITY CONTROL

E.1. Review the Pre-Audit Worksheet and list items from the Quality Control section of the Pre-Audit Worksheet to be discussed.

Q1.

A1.

Q2.

A2.

Q3.

A3.

Q4.

A4.

Q5.

A.5

APPENDIX I (continued)

E.2. Quality Control Manual Checklist

Item	Yes	No	Comment
Does the laboratory maintain a Quality Control Manual?			
Does the manual address the important elements of a QC program, including the following:			
a. Personnel?			
b. Facilities and equipment?			
c. Configuration control of instruments?			
d. Documentation of procedures?			
e. Procurement and inventory practices?			
f. Preventive maintenance?			
g. Reliability of data?			
h. Data validation?			
i. Feedback and corrective action?			
j. Instrument calibration?			
k. Record keeping?			
l. Internal audits?			
Does the QC Manual specify the frequency of duplication and spiked sample analysis?			
Is at least 10 percent sample duplication required?			
Are QC responsibilities and reporting relationships clearly defined?			

E.3. Quality Control Procedures Checklist

Item	Yes	No	Comment
Select a representative number of analyses from the project list and review historical quality control data for these parameters. Are QC records adequate for the purposes of the project?			
Are reference standards analyzed with each set of samples?			
Have standard curves been adequately documented?			
Are laboratory standards traceable to the National Bureau of Standards, where appropriate?			
Have standards been analyzed every 20 or fewer samples to verify that the analytical method is in control?			
Have the prescribed number (QC Manual or Project Plan) of duplicate and spiked samples been analyzed?			
Do duplicate data fall within acceptable limits of precision?			
Are recoveries, calculated from spiked sample data, acceptable?			
Are quality control charts maintained for each routine analysis?			
Do QC records show corrective action when analytical results fail to meet QC criteria?			
Do supervisory personnel review the data and QC results?			

E.4. Are quality control procedures and records generally adequate to accomplish the objectives of the project? ________________

Comments on quality control procedures and records:

F. DATA HANDLING

F.1. Review the Pre-Audit Worksheet and list items from the Data Handling section of the Pre-Audit Worksheet to be discussed.

Q1.
A1.
Q2.
A2.
Q3.
A3.
Q4.
A4.
Q5.
A5.

F.2. Data Handling Checklist

Item	Yes	No	Comment
Ask for a demonstration of data handling procedures from initial sample check-in to reporting of the final data. Are these procedures clear and adequate to avoid data errors?			
Are data calculations checked by a second person?			
Are data calculations documented?			
Do records indicate corrective action that has been taken on rejected data?			
Are limits of detection determined and reported properly?			
Are results which are below the analytical detection limit reported as such?			
Are the data reported to a justifiable number of significant figures?			
Are all data and records retained at least 3 years beyond completion of the project?			
Are quality control data (e.g., standard curve, results of duplication and spikes) accessible for all analytical results?			
Are data reported in the appropriate units (e.g., ppm, mg/l, dry weight, metric measure)?			

F.3. Are data handling procedures adequate to accomplish the objectives of the project and to trace the accompanying quality control results? ______________

Comments on data handling:

G. SUMMARY

G.1. Summary Checklist

Item	Yes	No	Comment
Do responses to audit questions indicate that project and supervisory personnel are aware of QA and its application to the project?			
Do project and supervisory personnel place positive emphasis on QA/QC?			
Have responses with respect to QA/QC aspects of the project been open and direct?			
Has a cooperative attitude been displayed by all project and supervisory personnel?			
Are the personnel assigned to the project qualified?			
Does the organization place the proper emphasis on quality assurance?			
Have any QA/QC deficiencies been discussed before leaving?			
Is the overall quality assurance adequate to accomplish the objectives of the project?			
Are any corrective actions required? If so, list the necessary actions below.			

G.2. Summary Comments and Corrective Actions

GLOSSARY

agency: the United States Environmental Protection Agency (EPA).

analytical or reagent blank: a blank used as a baseline for the analytical portion of a method. For example, a blank consisting of a sample from a batch of absorbing solution used for normal samples, but processed through the analytical system only, and used to adjust or correct routine analytical results.

blank or sample blank: a sample of a carrying agent (gas, liquid, or solid) that is normally used to selectively capture a material of interest and that is subjected to the usual analytical or measurement process to establish a zero baseline or background value, which is used to adjust or correct routine analytical results.

confidence interval: a value interval that has a designated probability (the confidence coefficient) of including some defined parameter of the population.

confidence limits: the outer boundaries of a confidence interval.

contract: the legal instrument reflecting a relationship between the Federal Government and a State or local government or other recipient: (1) whenever the principal purpose of the instrument is the acquisition, by purchase, lease, or barter, of property or services for the direct benefit or use of the Federal Government; or (2) whenever an executive agency determines in a specific instance that the use of a type of procurement contract is appropriate.

cooperative agreement: the legal instrument reflecting the relationship between the Federal Government and a State or local government or other recipient whenever: (1) the principal purpose of the relationship is the transfer of money, property, services, or anything of value to the State or local government or other recipient to accomplish a public purpose of support or stimulation authorized by Federal statute, rather than acquisition, by purchase, lease, or barter, of property or services for the direct benefit or use of the Federal Government; and (2) substantial involvement is anticipated between the executive agency acting for the Federal Government and the State or local government or other recipient during performance of the contemplated activity.

data validation: a systematic effort to review data to identify any outliers or errors and thereby cause deletion or flagging of suspect values to assure the validity of the data to the user. This "screening" process may be done by manual and/or computer methods, and it may utilize any consistent technique such as sample limits to screen out impossible values or complicated acceptable relationships of the data with other data.

extramural review: technical and scientific review of a research or demonstration proposal by a qualified individual not an employee of the Environmental Protection Agency, such as an employee of industry or an academic institution.

grant: the legal instrument reflecting the relationship between the Federal Government and a State or local government or other recipient in which: (1) the principal purpose of the relationship is the transfer of money, property, services, or anything of value to the State or local government or other recipient in order to accomplish a public purpose of support or stimulation authorized by Federal statute, rather than acquisition, by purchase, lease, or barter, of property or services for the direct benefit or use of the Federal Government; and (2) no substantial involvement is anticipated between the executive agency, acting for the Federal Government, and the State or local government or other recipient during performance of the contemplated activity.

grantee: any individual, agency, or entity that has been awarded a grant pursuant to grant regulations or has received a cooperative agreement.

in-house project: a project carried out by EPA staff in EPA facilities.

intramural review: technical and scientific review of a research or demonstration proposal by a qualified employee of the Environmental Protection Agency.

measures of dispersion or variability: measures of the differences, scatter, or variability of values of a set of numbers. Measures of the dispersion or variability are the range, the standard deviation, the variance, and the coefficient of variation.

performance audit: planned independent (duplicate) sample checks of actual output made on a random basis to arrive at a quantitative measure of the quality of the output. These independent checks are made by an auditor subsequent to the routine checks by a field technician or laboratory analyst.

performance test sample: a sample or sample concentrate (to be diluted to a specified volume before analysis) of known (to EPA only) true value which has been statistically established by interlaboratory tests. These samples are commonly provided to laboratories to test analytical performance. Analytical results are reported to EPA for evaluation.

pre-application: a preliminary proposal outlining the intent of a proposed project. Letter format is normally used, in which case the program office to which the pre-application is referred responds directly to the submitter to encourage or discourage followup.

pre-award survey: on-site inspection, review, and discussions with a prospective grantee or prospective contractor at his/her facilities. Discussions would normally include, but not be limited to, the proposed project plan, personnel, procedures, schedule, and facilities. Normally conducted after receipt of a "best and final" offer, but prior to final selection of a contractor.

proficiency testing: special series of planned tests to determine the ability of field technicians or laboratory analysts who normally perform routine analyses. The results may be used for comparison against established criteria, or for relative comparisons among the data from a group of technicians or analysts.

program: the technical office or staff that has responsibility for a part of the Agency's operations. For R&D grants, the "programs" are the Office of Research and Development, the Office of Air Quality Planning and Standards, the Office of Solid Waste Management Programs, and the Office of Mobile Sources Air Pollution Control.

project officer: the EPA official designated in the grant or contract agreement as the Agency's principal contact with the grantee on a particular grant. This person is the individual responsible for project monitoring and for recommendations on or approval of proposed project changes.

quality: the totality of feature and characteristics of a product or service that bears on its ability to satisfy a given purpose. For pollution measurement systems, the product is pollution measurement data, and the characteristics of major importance are accuracy, precision, and completeness. For monitoring systems, "completeness," or the amount of valid measurements obtained relative to the amount expected to have been obtained, is usually a very important measure of quality. The relative importance of accuracy, precision, and completeness depends upon particular purpose of the user.

quality assurance: actions taken by the Laboratory (IERL-Ci) line organization under the specific auspices of the Office of the Director, to assure that quality control policies and procedures are being properly implemented and appropriate levels of accuracy, reliability, and comparability are being achieved in the sampling and analysis activities (including data reduction and handling) of the Laboratory to fulfill the Laboratory's assigned mission.

quality assurance manual: an orderly assembly of management policies, objectives, principles, and general procedures by which an agency or laboratory outlines how it intends to produce quality data.

quality assurance plan: an orderly assembly of detailed and specific procedures by which an agency or laboratory delineates how it produces quality data for a specific project or measurement method. A given agency or laboratory would have only one quality assurance manual, but would have a quality assurance plan for each of its projects or programs (group of projects using the same measurement methods; for example, a laboratory service group might develop a plan by analytical instrument since the service is provided to a number of projects).

quality control: actions taken by the Laboratory (IERL-Ci) organization (on in-house projects) and by contractors/grantees (on extramural projects) in day-to-day activities to achieve desired accuracy, reliability, and comparability in the results obtained from sampling and analysis activities. Review by contractors/grantees of their overall quality control activities is "quality assurance" to them, but "quality control" from the Laboratory's viewpoint.

range: the difference between the maximum and minimum values of a set of values. When the number of values is small (i.e., 12 or less), the range is a relatively sensitive (efficient) measure of variability.

reliability (general): the ability of an item or system to perform a required function under stated conditions for a stated period of time.

reliability (specific): the probability that an item will perform a required function under stated conditions for a stated period of time.

representative sample: a sample taken to represent a lot or population as accurately and precisely as possible. A representative sample may be either a completely random sample or a stratified sample, depending upon the objective of the sampling and the conceptual population for a given situation.

spiked sample: a normal sample of material (gas, solid, or liquid) to which is added a known amount of some substance of interest. The extent of the spiking is unknown to those analyzing the sample. Spiked samples are used to check on the performance of a routine analysis or the recovery efficiency of a method.

standard deviation: the square root of the variance of a set of values:

$$s = \frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{n - 1}$$

If the values represent a sample from a larger population:

$$s = \frac{\sum_{i=1}^{N} (X_i - u)^2}{N}$$

where u is the true arithmetic mean of the population. The property of the standard deviation that makes it most practically meaningful is that it is in the same units as the values of the set, and universal statistical tables for the normal (and other) distributions are expressed as a function of the standard deviation. Mathematically, the tables could just as easily be expressed as a function of the variance.

standard reference material (SRM): a material produced in quantity, of which certain properties have been certified by the National Bureau of Standards (NBS) or other agencies to the extent possible to satisfy its intended use. The material should be in a matrix similar to actual samples to be measured by a measurement system or be used directly in preparing such a matrix. Intended uses include: (1) standardization of solutions, (2) calibration of equipment, and (3) monitoring the accuracy and precision of measurement systems.

standard reference sample (SRS): a carefully prepared material produced from or compared against an SRM (or other equally well characterized material) such that there is little loss of accuracy. The sample should have a matrix similar to actual samples used in the measurement system. These samples are intended for use primarily as reference standards to: (1) determine the precision and accuracy of measurement systems, (2) evaluate calibration standards, and (3) evaluate quality control reference samples. They may be used "as is" or as a component of a calibration or quality control measurement system. Examples: an NBS-certified sulfur dioxide permeation device is an SRM. When used in conjunction with an air dilution device, the resulting gas becomes an SRS. An NBS-certified nitric oxide gas is an SRM. When diluted with air, the resulting gas is an SRS.

standardization: a physical or mathematical adjustment or correction of a measurement system to make the measurements conform to predetermined values. The adjustments or corrections are usually based on a single-point calibration level.

calibration standard: a standard prepared by the analyst for the purpose of calibrating an instrument. Laboratory control standards are prepared independently from calibration standards for most methods.

detection limit: that number obtained by adding two standard deviations to the average value obtained for a series of reagent blanks that are analyzed over a long time period (several weeks or months).

duplicate analyses: the collection of two samples from the same fieldsite which are analyzed at different times but usually on the same day.

laboratory control standard: a standard of known concentration prepared by the analyst.

reference standard: a solution obtained from an outside source having a known value and analyzed as a blind sample.

relative percent error for duplicate analyses: the difference between the measured concentration for the duplicate pair times 100 and divided by the average of the concentration.

relative percent error for laboratory control standards: the difference between the measured value and the theoretically correct value times 100 and divided by the correct value.

relative percent error of a reference sample analysis: the difference between the correct and measured values times 100 and divided by the correct concentration.

Standards Based Upon Usage

calibration standard: a standard used to quantitate the relationship between the output of a sensor and a property to be measured. Calibration standards should be traceable to standard reference materials or primary standards.

quality control reference sample (or working standard): a material used to assess the performance of a measurement or portions thereof. It is intended primarily for routine intralaboratory use in maintaining control of accuracy and would be prepared from or traceable to a calibration standard.

Standards Depending Upon "Purity" or Established Physical or Chemical Constants

primary standard: a material having a known property that is stable, that can be accurately measured or derived from established physical or chemical constants, and that is readily reproducible.

secondary standard: a material having a property that is calibrated against a primary standard.

standards in naturally-occurring matrix: standards relating to the pollutant measurement portions of air pollution measurement systems may be categorized according to matrix, purity, or use. Standards in a naturally-occurring matrix include Standard Reference Materials and Standard Reference Samples.

statistical control chart (also Shewhart control chart): a graphical chart with statistical control limits and plotted values (usually in chronological order) of some measured parameter for a series of samples. Use of the charts provides a visual display of the pattern of the data, enabling the early detection of time trends and shifts in level. For maximum usefulness in control, such charts should be plotted in a timely manner, i.e., as soon as the data are available.

system audit: a systematic on-site *qualitative* review of facilities, equipment, training, procedures, recordkeeping, validation, and reporting aspects of total (quality assurance) system to arrive at a measure of the capability and ability of the system. Even though each element of the system audit is qualitative in nature, the evaluation of each element and the total may be quantified and scored on some subjective basis.

Test Variability

accuracy: the degree of agreement of a measurement (or an average of measurements of the same thing), X, with an accepted reference or true value, T, usually expressed as the difference between the two values, X-T, or the difference as a percentage of the reference or true value, 100(X-T)/T, and sometimes expressed as a ratio, X/T.

bias: a systematic (consistent) error in test results. Bias can exist between test results and the true value (absolute bias, or lack of accuracy), or between results from different sources (relative bias). For example, if different laboratories analyze a homogeneous and stable blind sample, the relative biases among the laboratories would be measured by the differences existing among the results from the different laboratories. However, if the true value of the blind sample were known, the absolute bias or lack of accuracy from the true value would be known for each laboratory.

precision: a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is most desirably expressed in terms of the standard deviation but can be expressed in terms of the variance, range, or other statistics. Various measures of precision exist depending upon the "prescribed similar conditions."

replicates: repeated but independent determinations of the *same sample*, by the *same analyst*, at essentially the *same time* and *same conditions*. Care should be exercised in considering replicates of a portion of an analysis and replicates of a complete analysis. For example, duplicate titrations of the same digestion are not valid replicate analyses, although they may be valid replicate titrations. Replicates may be performed to any degree, e.g., duplicates, triplicates, etc.

reproducibility: the precision, usually expressed as a standard deviation, measuring the variability among results of measurements of the *same sample* at different laboratories.

variance: mathematically, for a sample, the sum of squares of the differences between the individual values of a set and the arithmetic mean of the set, divided by one less than the number of values.

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16. ABSTRACT

This document provides guidelines to Industrial Environmental Research Laboratory-Cincinnati (IERL-Ci) Project Officers for (1) incorporating quality assurance (QA) criteria in contract procurement and grant awards, (2) monitoring quality assurance of extramural projects, and (3) conducting QA audits for projects involving sampling and analysis activities. The Project Officer's responsibilities are described for the initiation, monitoring, and satisfactory conclusion of contracts, research and demonstration grants, and cooperative agreements of the type normally funded by IERL-Ci. Guidance is provided to assure QA is adequately addressed during project conception and solicitation and that prospective grantees are informed of QA requirements. A technical evaluation system is presented for the evaluation of the QA aspects of proposals and grant applications. The basic elements of an acceptable QA program and of a project QA plan are described, and the Project Officer's role in QA monitoring is discussed. A procedure is described for conducting QA audits of active projects. Checklists are included to assist the Project Officer.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Quality Assurance Sampling and Analysis Contract Procurement QA Quality Control		

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